CHEVROLET HEAVY DUTY TRUCK SERVICE MANUAL

CHEVROLET

SERIES 70-90

ST 135-70

1970

CHEVROLET HEAVY DUTY TRUCK

(SERIES 70, 80, and 90)

SHOP MANUAL

FOREWORD

This manual contains, Service procedures for maintenance adjustments, minor service operations, and replacement of components for Chevrolet Series 70, 80 and 90 Heavy Duty Trucks. For disassembly and assembly of major components (overhaul operations) continue to refer to the 1969 Chevrolet Heavy Duty Truck Shop Manual.

CHASSIS SERVICE SECTION

The manual includes procedures for maintenance and adjustments, minor service operations, and removal and installation of components.

The Index on this page enables the user to quickly locate any desired section. At the beginning of each individual section containing more than one major subject is a Table of Contents, which gives the page number on which each major subject begins. An Index is placed at the beginning of each major subject within the section.

A summary of Special Tools will be found following Section 13 while Specifications covering vehicle components are presented at the end of each section.

This manual should be kept in a handy place for ready reference. If properly used, it will enable the technician to better serve the owners of Chevrolet vehicles.

All information, illustrations and specifications contained in this literature are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

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CHEVROLET MOTOR DIVISION
General Motors Corporation
DETROIT, MICHIGAN

SERVICE SECTION INDEX

Printed in U.S.A.

INTRODUCTION

This manual contains on-the-vehicle maintenance, light repair information, and unit replacement on all truck series listed on page iv and v. Important information on the arrangement and use of this manual will be found on page iii. Operation of the vehicles from the standpoint of the driver is contained in a separate Owner's and Driver's manual which is furnished with every new Chevrolet Truck.

Every effort has been made to include timely and adequate information on the various units and systems used on Chevrolet Trucks.The general maintenance and light repair procedures in the various manual sections are the result of extensive service experience. This information should serve not only as a reference for the experienced mechanical force, but also as a comprehensive text for training purposes.

In some cases, considerable space is devoted to describing the operation of a unit or system. The use of this space is justified by the presumption that in order for a mechanic to maintain a unit or system in a serviceable condition, he must first understand how the unit or system should function.

All information contained in this manual is based on the latest product information available at the time of publication approval. Chevrolet Motor Division reserves the right to make changes in design or add improvements at any time without incurring any obligation to install same on vehicles previously purchased.

TRUCK MODEL DESIGNATION

CHASSIS TYPE SYMBOL

(M) Conv. Cab (114" BBC)
(D) Tilt Cab (Alum.) (Tandem Axle)
(F) Tilt Cab (Alum.)
(H) Conv. Cab (92" BBC)
(J) Conv. Cab (92" BBC) (Tandem Axle)
(T) Tilt Cab (Steel)
(W) Tilt Cab (Steel) (Tandem Axle)

GVW RANGE NUMBER

H M 7 1 5 1 3

ENGINE TYPE SYMBOL

(C) L-6 NHC250 Turbo Chg. Diesel
(H) 8V-71 2-Cycle Diesel
(I) 6-71 2-Cycle Diesel
(N) L-6 NHC250 Diesel
(M) V6 Gasoline
(V) 6V-53 2-Cycle Diesel

Identify Wheelbase CA, Type of brakes, and body

GENERAL INFORMATION

IMPORTANT—READ THIS PAGE

TRUCK MODELS COVERED

This manual contains "on-the-vehicle" maintenance and light repair information on Chevrolet Truck Models listed on pages iv and v. Since many truck models with various combinations of equipment are covered in this manual, the reader must necessarily refer to truck model applications and methods of distinguishing design differences in each manual section.

All standard equipment and the most commonly used regular production options are included in this manual. Many special equipment and accessory items are available on these Chevrolet Trucks, however, these items are too numerous to permit their coverage in this manual.

MANUAL ARRANGEMENT

This manual is divided into major sections in the sequence shown on the margin of the title page. A black tab bearing the major section number is placed on the first page of each major section which indexes with the tab on the title page. Many of the major sections are divided into sub-sections, each sub-section containing important and specific information on related units or components. A section index is also included on the first page of each major section, when the major section is divided into sub-sections.

PAGE AND ILLUSTRATION NUMBERS

The manual pages are numbered consecutively throughout the manual. Illustrations are numbered consecutively within each section, or within each sub-section when the major section is so divided.

SPECIFICATIONS

Service data, fits, and tolerances are listed at end of each section or sub-section under the heading "Specifications." In some cases reference must also be made to these "Specifications" for model application and methods of distinguishing the various design and construction differences.

Manufacturers model or part numbers are used in many instances in the "Specifications" tabulations. These numbers are provided primarily for unit identification or truck model application reference, and should be referred to when ordering parts. All detail service part numbers must be obtained from the applicable Parts Book.

SPECIAL TOOLS

Special tools and equipment are mentioned, and in many instances illustrated, throughout the text. These tools are specially designed to accomplish certain operations efficiently and readily. Such tools are mentioned in the text by tool vendor's numbers.

SERVICE BULLETINS

Service bulletins are issued, when required, supplementing or in some cases superseding information in this manual. Information in these bulletins should be noted in the text of the applicable manual section and the bulletin filed for ready reference.

OPERATION

Operating instructions from the standpoint of the driver are included in a booklet entitled "Owner's and Driver's Manual" which is placed in the cab of every new Chevrolet Truck.

ALPHABETICAL INDEX

Important subjects, with manual page number references, are alphabetically listed in the index in the back of this manual.

MODEL DATA

TRUCK SERIES	ENGINE		CLUTCH		FRONT AXLE		REAR AXLE		TRANSMISSION	
	STD.	OPT.	STD.	OPT.	STD.	OPT.	STD.	OPT.	STD.	OPT.
HM80	401M	478M	13″-2	14″-2	F070	F090	17121	17221, 18121, 18221, 19221	285V	282V, 387V, 5652, 5752C, MT40
HV70	6V-53N	—	14″-2	—	F070	F090, F120	17221	18221, 19221	5752C	—
JM80	401M	478M	13″-2	14″-2	F090	F120	30DSC	34DSC, SLHD, SQHD	5652/w 6041 Aux.	385V, 401V, 7041 Aux. MT40
JV70	6V-53N	—	14″-2	—	F090	F120	34DSC	SLHD	385V/w 7041 Aux.	—
TV70	6V-53N	—	14″-2	—	F070	F090, F120	17221	19221	5752C	—
HI90	6-71N	—	14″-2	—	F090	F120	18221	19121, 19221, R170	68528	6853C, RT910
HN90	NHC250	NH 230	14″-2	15½″-2	F090	F120	18221	19121, 19221, R170	7452E	RT910, RT0913

MODEL DATA (Cont'd)

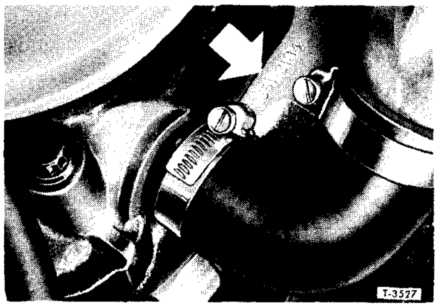
TRUCK SERIES	ENGINE		CLUTCH		FRONT AXLE		REAR AXLE		TRANSMISSION	
	STD.	OPT.	STD.	OPT.	STD.	OPT.	STD.	OPT.	STD.	OPT.
JI90	6-71N	—	14″-2	—	F090	F120, F160	SLHD	SQHD, 34D3C	RT910	RT0913, 6852K
JN90	NHC250	NH230	14″-2	15½″-2	F090	F120, F160	34DSC	SLHD, SQHD, 34D3C	RT910	RT0913, 7352B, 8552R, 8341 Aux.
MH90	8V-71N	—	14″-2	—	F090	F120	SLHD	SQHD, 34D3C	RT910	RT0913, 8552R, 8516-3B, 8716-3B
MI90	6-71N	—	14″-2	—	F090	F120, F160	SLHD	—	RT910	RT0913
DC90	NHCT270	NTC335	14″-2	15½″-2	F120	F160	SLHD	SQHD, SSHD	RT910	RT0913, 8516-3B, 8716-3B
DH90	8V-71N	—	14″-2	15½″-2	F120	F160	SLHD	SQHD, SSHD, 34DSC, 34D3C	RT910	RT0913; T905A, 8516-3B, 8716-3B 8552A, 8554A, 8341 Aux. 8345 Aux.
DI90	6-71N	—	14″-2	—	F120	F160	34D3C	34DSC, SLHD, SQHD	7352B	RT910, RT0913,
DN90	NHC250	NH230	14″-2	15½″-2	F120	F160	34D3C	34DSC, SLHD, SQHD	7352B	RT910, RT0913
FC90	NHCT270	NTC335	14″-2	15½″-2	F120	F160	19121	R170	RT910	RT0913
FH90	8V-71N	—	14″-2	15½″-2	F120	F160	19121	R170	RT910	RT0913, 8516-3B, 8716-3B
FI90	6-71N	—	14″-2	—	F120	F160	18221	19121, 19221, R170	6852S	7452E, RT910, RT0913
FN90	NHC250	NH230	14″-2	15½″-2	F120	F160	18221	19121, 19221, R170	7452E	RT910, RT0913

VEHICLE MODEL IDENTIFICATION AND WEIGHT RATING PLATE

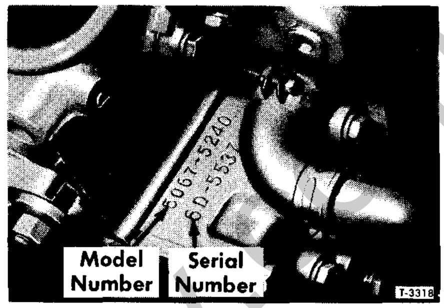
The vehicle identification and weight rating plate is located on the cab left door pillar of all models.

ENGINE SERIAL NUMBERS

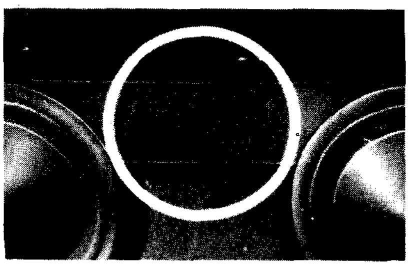
The engine serial numbers on all engines are located on the right side as shown below.



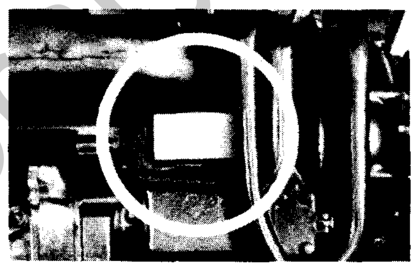
V6- Gasoline



6V-53 Diesel



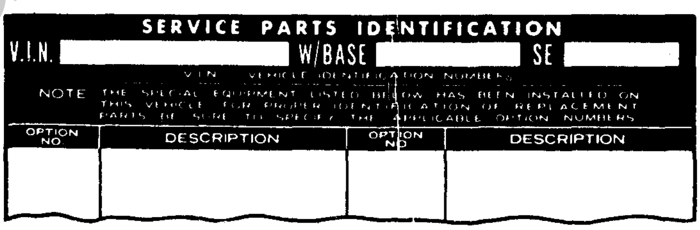
8V-71 Diesel



6-71 Diesel

SERVICE PARTS IDENTIFICATION

The "Service Parts Identification" label is located on inside of glove compartment door of steel tilt and conventional cab models. This label lists all special equipment installed on the vehicle. This information is imprinted on the label at the factory and represents only the special equipment on the vehicle when it was shipped from the factory. Always refer to this information when ordering parts.


SERVICE PARTS IDENTIFICATION

V.I.N. ____ W/BASE ____ SE ____

V.I.N. VEHICLE IDENTIFICATION NUMBERS

NOTE THE SPECIAL EQUIPMENT LISTED BELOW HAS BEEN INSTALLED ON THIS VEHICLE. FOR PROPER IDENTIFICATION OF REPLACEMENT PARTS BE SURE TO SPECIFY THE APPLICABLE OPTION NUMBERS

OPTION NO.	DESCRIPTION	OPTION NO.	DESCRIPTION

SECTION 0
LUBRICATION

INDEX

GENERAL INFORMATION

NOTE: If vehicle is equipped with Cummins engine refer to "CUMMINS OPERATION AND MAINTENANCE MANUAL" for maintenance services. See "Maintenance Operations."

One of the most important items to good truck care is the lubrication of all necessary points with the Right Lubricant, at the Right Time, and in the Right Way. It is the responsibility of the owner to maintain proper lubrication practices as recommended on following pages.

Lubrication charts on the following pages will locate lubrication point. Each point is numbered on the charts, the number is keyed to explanatory text.

Each item shown on charts requiring lubrication is covered with a lubricant symbol. Further explanations of these symbols start on page 12. These explanations include type of lubricant recommended, and detailed instructions regarding lubricant application.

The charts show recommended intervals when various points and units should be lubricated. The intervals recommended are for normal use; however, severe operating conditions may require more frequent intervals. The recommended intervals should be followed until operating experience indicates other periods are more desirable.

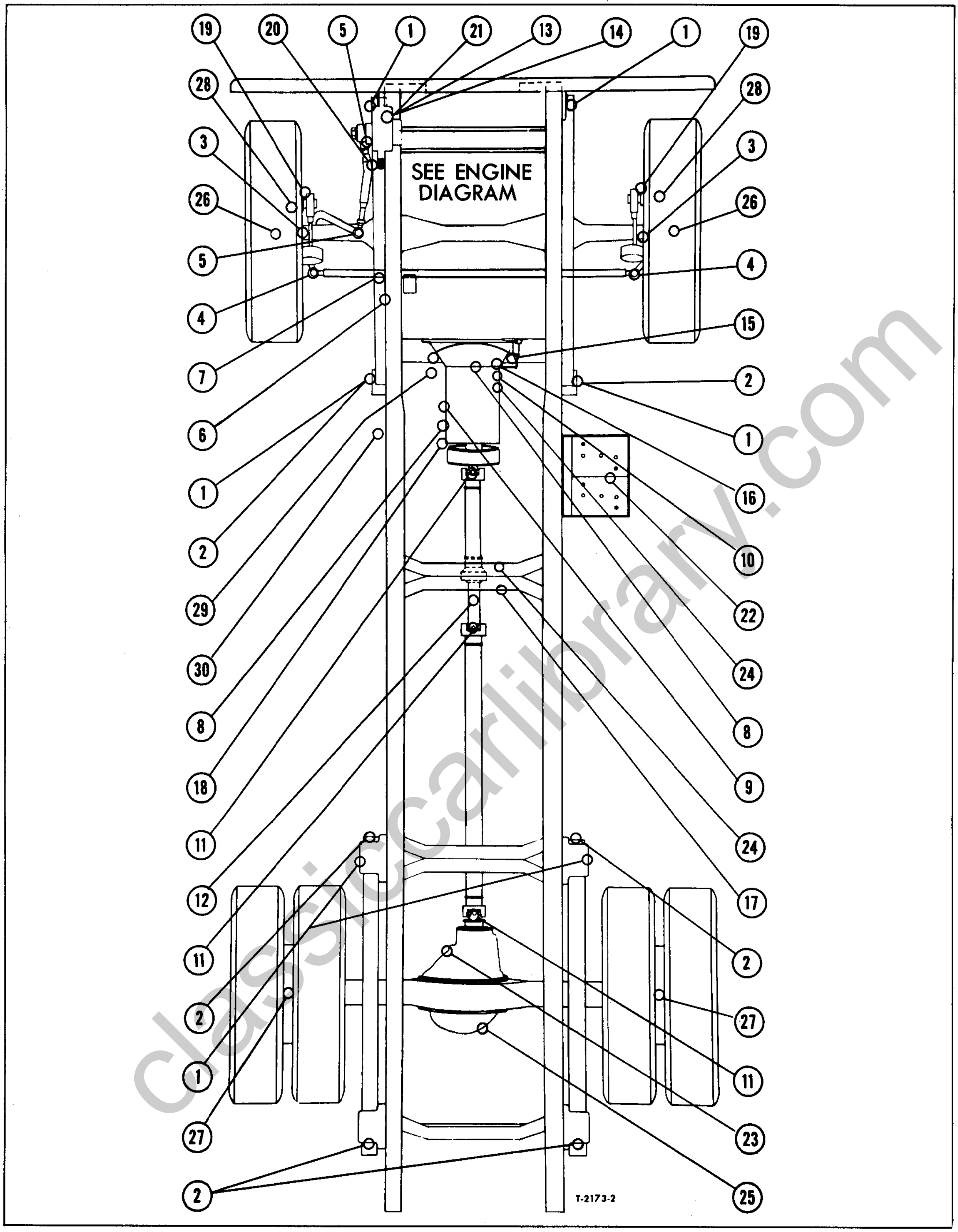


Figure 1—Lubrication Chart (Conventional Cab Models)

LUBRICATION DATA
(CHART ON OPPOSITE PAGE)

Item No.	Item	Remarks	Symbol	Miles (c)
1	Spring Shackles & Brackets (d)	2 fittings each shackle	MPG	6,000
		1 fitting each bracket	MPG	6,000
2	Spring Slip Pads (d)	Apply each end	MPG	6,000
3	Steering Knuckles	2 fittings each side	MPG	6,000
4	Steering Tie Rod Ends	1 fitting each end	MPG	6,000
5	Steering Drag Link	1 fitting each end	MPG	6,000
6	Steering Idler Lever (d)	1 fitting	MPG	6,000
7	Power Steering Cylinder Ends (d)	2 fittings	MPG	6,000
8	Tran. Shift Relay Lever (d)	1 fitting	MPG	6,000
9	Transmission Shift Rod U-Joints (d)	1 fitting each joint	MPG	6,000
10	Auxiliary Trans. Shift Tower (d)	1 fitting	MPG	6,000
11	Propeller Shaft U-Joints	1 fitting each joint	MPG	6,000
12	Propeller Shaft Slip Joint	1 fitting each joint	MPG	6,000
13	Steering Column U-Joints	1 fitting each joint	MPG	6,000
14	Steering Column Slip Joint	1 fitting	MPG	6,000
15	Clutch Release Cross Shaft (d)	1 fitting each end	MPG	6,000
16	Clutch Release Bearing	Cup or fitting (d)	S27	6,000
17	Tru-Stop Brake (d)	4 or 8 fittings	MPG	6,000
18	Speedometer Adapter	1 fitting	MPG	6,000
19	Brake Camshaft - F. (e)	1 fitting ea. (apply sparingly)	MPG	6,000
20	Clutch and Brake Master Cylinder	Fill - ½" below opening	S12	6,000
21	Steering Gear Housing	To level of filler plug	SG	6,000
22	Battery Terminals	Keep coated	S3	6,000
23	Electric Shift Unit (2-Spd.)	To level of filler plug	E	12,000
24	Transmission (N.P.)	To level of filler plug	MPO	6,000
		Drain and refill	MPO	12,000
24	Transmission (Clark) (Fuller)	To level of filler plug	GO	6,000
		Drain and refill	GO	12,000
24	Transmission (Spicer)	To level of filler plug	ES	6,000
		Drain and refill	ES	12,000
24	Allison Automatic (d)	Drain and refill	S19	12,000
		Keep to "FULL" mark	S19	1,000
24	Transmission - Auxiliary (d)	Drain and refill	ES	12,000
		To level of filler plug	ES	6,000
25	Rear Axle	To level of filler plug	MPO	6,000
		Drain and refill	MPO	24,000(b)
26	Front Wheel Bearings (g)	Hand pack or use lubricator	MPG	20,000(a)
27	Rear Wheel Bearings (h)	Hand pack or use lubricator	MPG	20,000(a)
28	Brake Cam Roller Pins - F. (e)	Apply	E	20,000
29	Brake Air Cleaner (d)	Clean and reinstall	-	6,000

(a) Or once a year, whichever occurs first.
(b) Or every 6 months, whichever occurs first.
(c) When "MPG" (Multi-Purpose Grease) is specified, lubricate every 6,000 miles or 60 days, whichever occurs first.
(d) If used.
(e) Air Brake only.
(f) Hydraulic Brakes only
(g) Optional oil lubricated front wheel bearings use "GO" type oil.
(h) No periodic servicing with oil lubricated bearings (Stemco Seals).

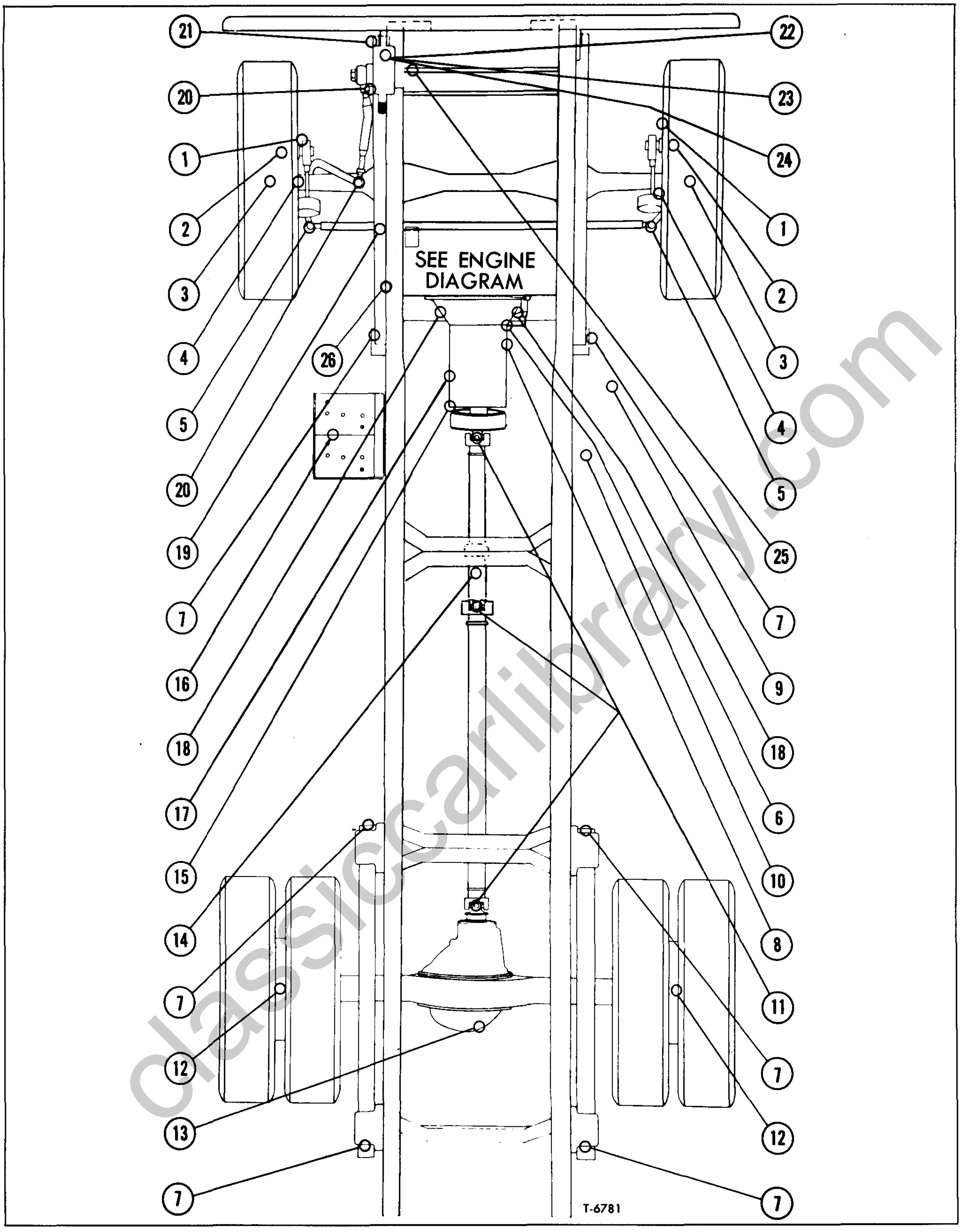


Figure 2—Lubrication Chart (Aluminum Tilt Cab Models)

LUBRICATION DATA
(CHART ON OPPOSITE PAGE)

Item No.	Item	Remarks	Symbol	Miles (c)
1	Brake Camshaft - Front	1 fitting each (apply sparingly)	MPG	6,000
2	Brake Cam Roller Pins - Front	Apply	E	20,000
3	Front Wheel Bearings (f)	Hand pack or use lubricator	MPG	20,000 (a)
4	Steering Knuckles	2 fittings each side	MPG	6,000
5	Steering Tie Rod Ends	1 fitting each end	MPG	6,000
6	Clutch Release Bearing	Cup or fitting (apply sparingly)	S27	6,000
7	Spring Slip Pads	Apply each end	MPG	6,000
8	Transmission (Fuller)	To level of filler plug	GO	6,000
		Drain and refill	GO	12,000
8	Transmission (Spicer)	To level of filler plug	ES	6,000
		Drain and refill	ES	12,000
9	Blower Air Cleaner	See instructions (See SEC. 6M)	-	--
10	Tilt Cab Hydraulic System	To level of filler plug	S23	6,000
11	Propeller Shaft U-Joints	1 fitting each joint	MPG	6,000
12	Rear Wheel Bearings (g)	Hand pack or use lubricator	MPG	20,000 (a)
13	Rear Axle	To level of filler plug	MPO	6,000
		Drain and refill	MPO	24,000 (b)
14	Propeller Shaft Slip Joint	1 fitting each joint	MPG	6,000
15	Speedometer Adapter Cable	1 fitting	MPG	6,000
16	Battery Terminals	Keep coated	S3	6,000
17	Transmission Shift Rod U-Joint	1 fitting each joint	MPG	6,000
18	Clutch Release Cross Shaft	1 fitting each end	MPG	6,000
19	Power Steering Cylinder Ends (d)	2 fittings	MPG	6,000
20	Steering Drag Link	1 fitting each end	MPG	6,000
21	Clutch Linkage (e)	3 fittings	MPG	6,000
22	Steering Gear Housing	To level of filler plug	SG	6,000
23	Steering Column U-Joints	1 fitting each joint	MPG	6,000
24	Steering Column Slip Joint	1 fitting	MPG	6,000
25	Accelerator Cross Shaft	1 fitting	MPG	6,000
26	Power Steering Reservoir (d)	To oil level mark	S19	6,000

(a) Or once a year, whichever occurs first.
(b) Or every six months, whichever occurs first.
(c) When "MPG" (Multi-Purpose Grease) is specified, lubricate every 6,000 miles or 60 days, whichever occurs first.
(d) If used.
(e) Front idler lever grease fitting is accessible through opening in front bumper. Rear idler lever grease fitting is accessible at transmission and clutch pedal grease fitting through splash shield opening. (Loosen screw, then move access cover to expose grease fitting.)
(f) Optional oil lubricated front wheel bearings use "GO" type oil.
(g) No periodic servicing with oil lubricated bearings (Stemco seals).

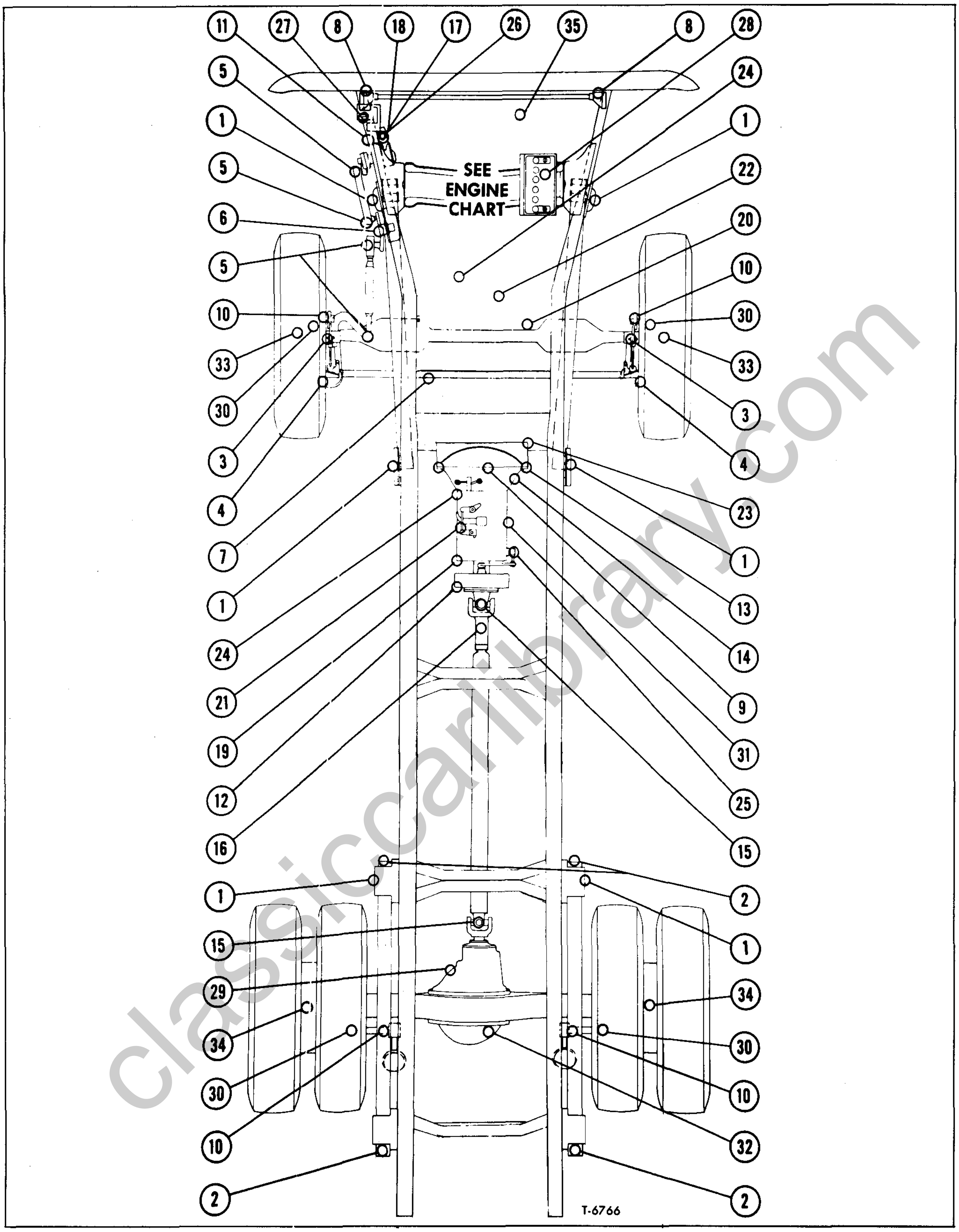
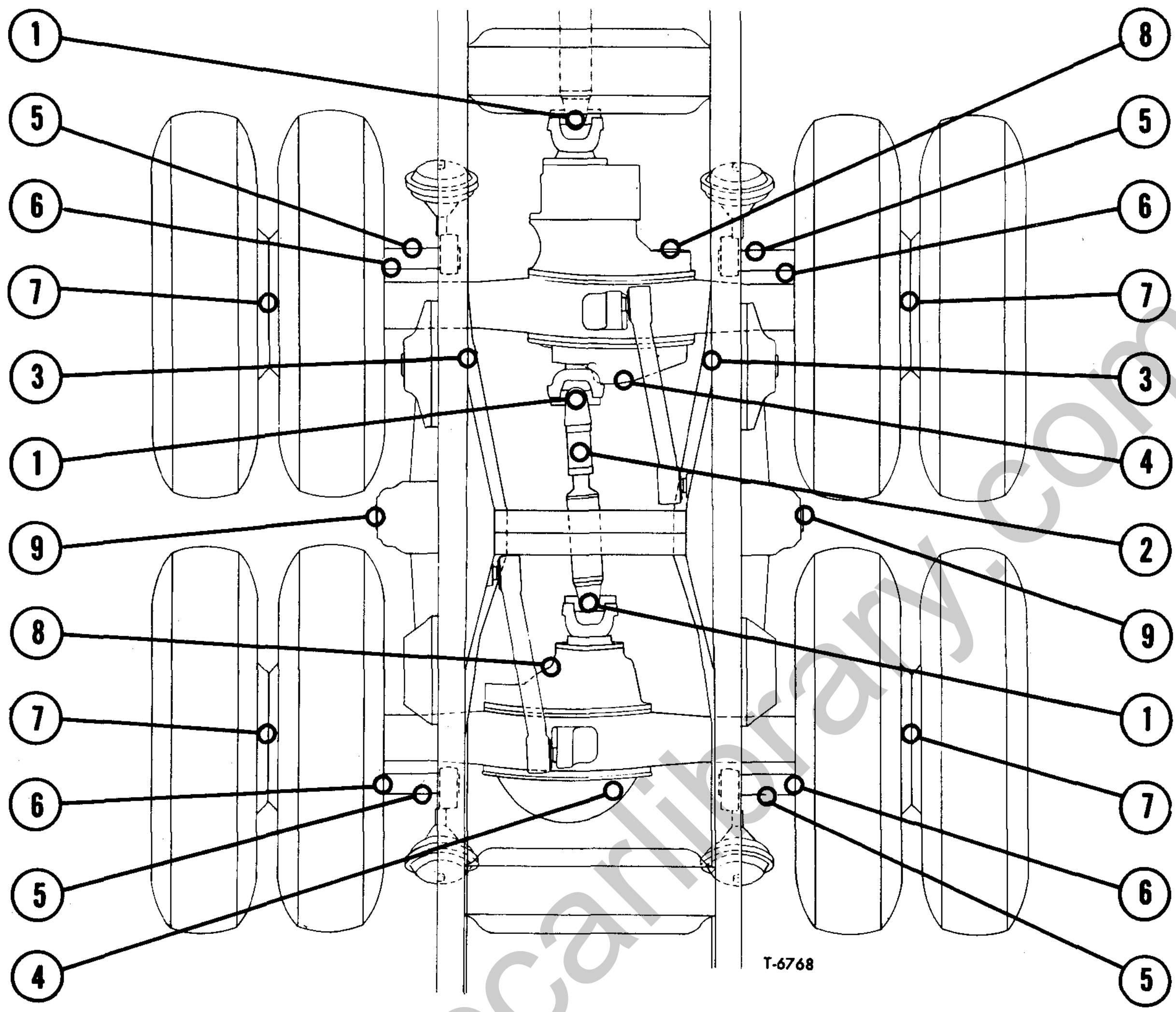


Figure 3—Lubrication Chart (Steel Tilt Cab Models)

LUBRICATION DATA
(CHART ON OPPOSITE PAGE)

Item No.	Item	Remarks	Symbol	Miles (c)
1	Spring Shackles and Brackets (d)	2 fittings each shackle	MPG	6,000
		1 fitting each bracket	MPG	6,000
2	Spring Slip Pads - Rear	Apply each end	MPG	6,000
3	Steering Knuckles	2 fittings each side	MPG	6,000
4	Steering Tie Rod Ends	1 fitting each end	MPG	6,000
5	Steering Drag Links	1 fitting each end	MPG	6,000
6	Steering Idler Lever (d)	1 fitting	MPG	6,000
7	Power Steering Cylinder Ends (d)	2 fittings	MPG	6,000
8	Cab Hinges	1 fitting each side	MPG	6,000
9	Cab Hold-Down Latch	1 fitting	MPG	6,000
10	Brake Camshafts (d & e)	1 fitting each	MPG	6,000
11	Clutch and Brake Pedals	2 fittings	MPG	6,000
12	Tru-Stop Brake (d)	4 or 8 fittings	MPG	6,000
13	Clutch Release Cross Shaft (d)	1 fitting each side	MPG	6,000
14	Clutch Release Bearing	Cup (when used)	S27	6,000
15	Propeller Shaft U-Joints	1 fitting each joint	MPG	6,000
16	Propeller Shaft Slip Joints	1 fitting each joint	MPG	6,000
17	Steering Column U-Joints	1 fitting each joint	MPG	6,000
18	Steering Column Slip Joint	1 fitting	MPG	6,000
19	Speedometer Adapter	1 fitting	MPG	6,000
20	Transmission Shift Levers	2 fittings	MPG	6,000
21	Transmission Shift Linkage (Clark)	2 fittings	MPG	6,000
22	Auxiliary Trans. Shift Tower (d)	1 fitting	MPG	6,000
23	Auxiliary Trans. Shift Levers (d)	2 fittings	MPG	6,000
24	Transmission Shift Rod U-Joints (d)	1 fitting each joint	MPG	6,000
25	Hand Brake Bell Crank (d)	1 fitting	MPG	6,000
26	Steering Gear Housing	To level of filler plug	SG	6,000
27	Clutch and Brake Master Cylinder (d)	Fill - ½" below opening	S12	6,000
28	Battery Terminals	Keep coated	S3	6,000
29	Electric Shift Unit (2-Spd. or 3-Spd.)	To level of filler plug	E	12,000
30	Brake Cam Roller Pins (e)	Apply	E	20,000
31	Transmission (N.P.)	To level of filler plug	MPO	6,000
		Drain and refill	MPO	12,000
31	Transmission (Clark) (Fuller)	To level of filler plug	GO	6,000
		Drain and refill	GO	12,000
31	Transmission (Spicer)	To level of filler plug	ES	6,000
		Drain and refill	ES	12,000
31	Transmission - Auxiliary (d)	To level of filler plug	ES	6,000
		Drain and refill	ES	12,000
31	Allison Automatic (d)	Full mark on dipstick	S19	1,000
		Drain and refill	S19	12,000
32	Rear Axle	To level of filler plug	MPO	6,000
		Drain and refill	MPO	24,000 (b)
33	Front Wheel Bearings	Hand Pack or use lubricator	MPG	20,000 (a)
34	Rear Wheel Bearings	Hand Pack or use lubricator	MPG	20,000 (a)
35	Brake Air Cleaner (d)	Clean and reinstall	-	6,000

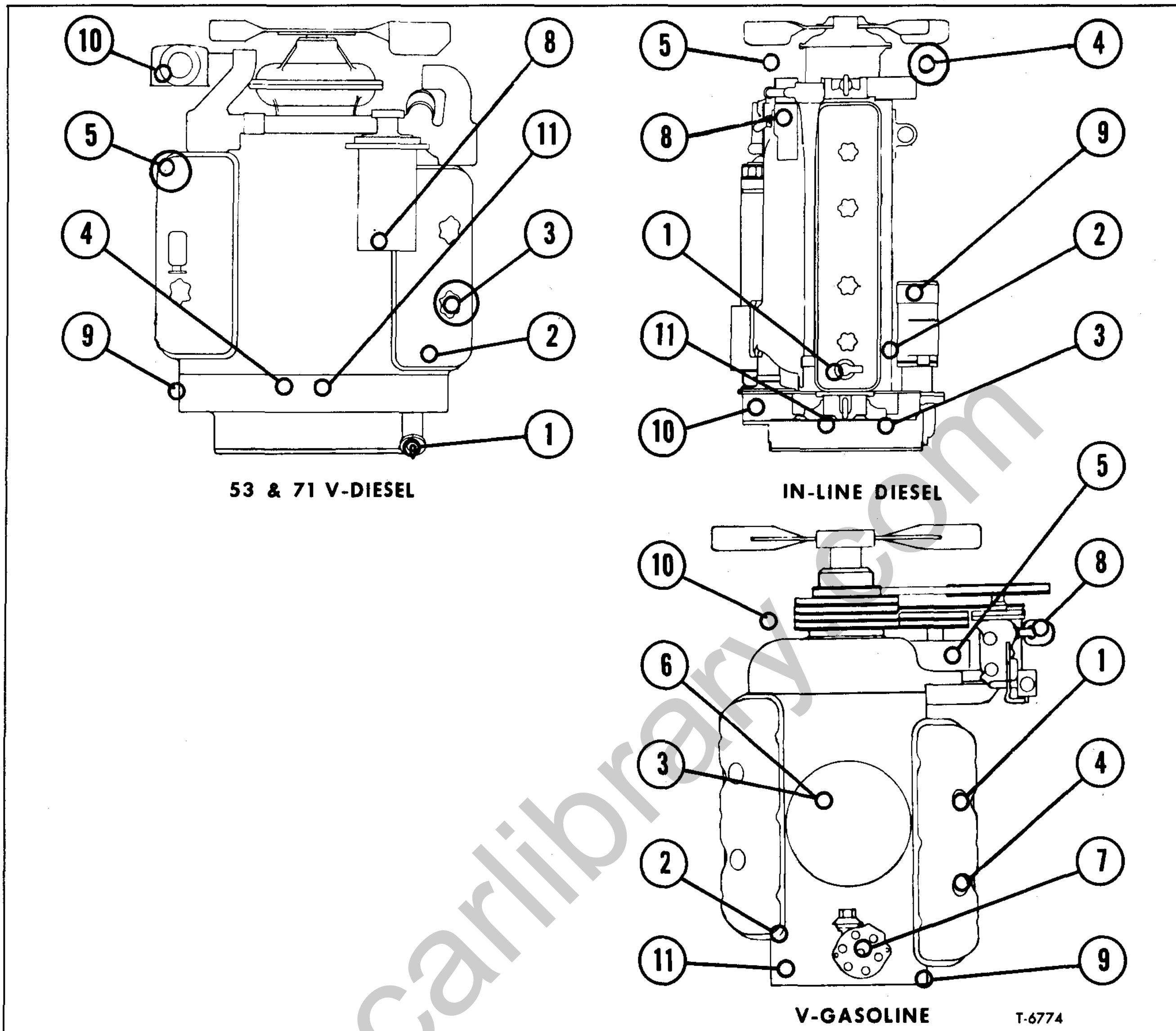
(a) Or once a year, whichever occurs first.
(b) Or every 6 months, whichever occurs first.
(c) When "MPG" Multi-Purpose Grease is specified lubricate every 6,000 miles or 60 days, whichever occurs first.
(d) If used.
(e) Air Brakes only.



Item No.	Item	Remarks	Symbol	Miles
1	Propeller Shaft U-Joint	1 fitting each joint	MPG	3,000
2	Propeller Shaft Slip Joint	1 fitting each joint	MPG	3,000
3	Rear Spring Pin (c)	1 fitting each side	MPG	6,000
4	Rear Axles	To level of filler plug	MPO	6,000
		Drain and refill	MPO	24,000 (b)
5	Brake Camshafts (c)	1 fitting each	MPG	6,000
6	Brake Shoe Roller Pins (c)	Apply	E	20,000
7	Wheel Bearings	Hand pack or use lubricator	MPG	20,000 (a)
8	Axle Shift Unit (2 or 3 Speed) (c)	To level of filler plug	E	12,000
9	Equalizer Beam (RT 38) only	1 fitting each beam	MPG	6,000

(a) Or once a year, whichever occurs first. (b) Or every 6 months, whichever occurs first. (c) If used.

Figure 4—Lubrication Chart Tandem Bevel (SLHD, SQHD, SSHD, 30DS, 34DS, and 34D3)



Item No.	Item	Remarks	Symbol	Miles
1	Engine	Keep to "FULL" mark	E	Daily
2	Engine Oil Filter	See instructions	-	-
3	Engine Air Cleaner	See instructions (Sec. 6M)	-	3,000
4	Crankcase Breather	See instructions	-	-
5	Air Compressor Air Strainer (b)	Clean and install	-	6,000
6	Governor Air Filter (c)	Clean and install	-	6,000
7	Distributor (c)	½ turn of cam lubricator	-	12,000 (a)
		Breaker pivot - 1 drop	E	6,000
		Rotor felt - 4 drops	E	6,000
8	Generator	No lubrication required		
9	Starter	See instructions	E	-
10	Power Steering Reservoir (b)	To "OIL LEVEL" mark	S19	6,000
11	Tachometer Adapter (b)	1 fitting	MPG	6,000

(a) Replace lubricator at 24,000 mile intervals. (b) If used. (c) Gas Engine Only.

Figure 5—Engine Lubrication Chart (Except Cummins)

No particular brand of lubricant is recommended as many reliable oil dealers can furnish the right lubricants when advised of the correct specifications or descriptions. However, the lubricant manufacturer must be responsible for the quality and satisfactory performance of his product.

MEANING OF LUBRICANT SYMBOLS

Symbol	Explanation	Page No.
"E"	Engine Oil	13
"MPO"	Multi-Purpose Gear Oil	19
"GO"	Gear Oil	20
"ES"	Lubricating Oil - Special	21
"MPG"	Multi-Purpose Grease	21
"SG"	Steering Gear Lubricant	22
"S3"	Petroleum Jelly	22
"S4"	Waterproof Grease	22
"S12"	Hydraulic Brake Fluid	23
"S17"	Special Grease	23
"S19"	Automatic Transmission Fluid	23
"S23"	Hydraulic Oil (Special)	25
"S27"	High Temperature Grease (Special)	25
"S28"	High Temperature Grease (Special)	26

CAPACITIES

CRANKCASE CAPACITIES

ENGINE MODEL	QTS. LESS FILTER U.S.	QTS. LESS FILTER IMP.	QTS. WITH FILTER U.S.	QTS. WITH FILTER IMP.
401M*, 478M*	9	7½	11	9¼
6V-53N	14	11¾	16	13¼
6-71	17	14½	19	15¾
8V-71	22	18¼	24	20
NH-230	20	16¾	23	19¼
NHC250	20	16¾	23	19¼
NHCT270	20	16¾	37	30¾**
NTC335	28	23¼	45**	37½**

* Add one quart when oil cooler is drained.
** 14 quart Lubrifiner is standard equipment.

Crankcase capacities are for normal refill. Add oil as indicated when oil filter is drained and element changed. Capacities given may be approximate - keep level as close as possible to "FULL" mark without over-filling. Do not operate with level below "ADD" mark, or "LOW" mark.

TRANSMISSION CAPACITIES

MAIN	PINTS U.S.	PINTS IMP.
CL282/285	8	6¾
CL325	14	11¾
CL385/387	14	11¾
CL401/408	22	18½
NP542	10	8¼
SP5652/5752	13	10¾
SP6852/6853	17	14¼
SP7352/7452	18	15
SP8552/8554	24	20
SP8716	36	30
T905	22	18½

MAIN	U.S.	IMP.
RT910	25	20¾
RTO913	24	20
RTO915	28	23¼
MT40	18*	15

*Filter change only.

AUXILIARY		
SP6041	8	6¾
SP7041	11	9¼
SP8341/8345/8031	12	10

REAR AXLE CAPACITIES

BEVEL	PINTS U.S.	PINTS IMP.
H162	20	16¾
L162	24	20
R170	43	35¾
E17121	29	24¼
E18121	29	24¼
E19121	34	28¼

TWO-SPEED		
H362	24	20
L362	26	21¾
E17221	29	24¼
E18221	29	24¼
E19221	34	28¼

TANDEM BEVEL	U.S.	IMP.
E30DSC	30 F. (2); 27 R.	25 F. (2); 20¾ R.
E34DSC	29 F. (2); 32 R.	24¼ F. (2); 26¾ R.
E34D3C	29 F. (2); 32 R.	24¼ F. (2); 26¾ R.
SLHD	32½ F. (1); 32 R.	27 F. (1); 26¾ R.
SQHD	34 F. (1); 31 R.	28¼ F. (1); 25¾ R.
SSHD	32 F. (1); 28 R.	26¾ F. (1); 23¼ R.

(1) Add 2 pints at top of inter-axle differential cover.
(2) Add 2 pints at forward hole in top of differential carrier.

POWER STEERING CAPACITIES

NOTE: This is approximate quantity due to hose lengths and cylinder sizes on various models:

	PINTS	
	U.S.	IMP.
POWER STEERING	8	6¾

ENGINE OIL (SYMBOL "E" ON CHARTS)

ENGINE OIL RECOMMENDATIONS

The oil industry markets various types of engine oil under certain service designations and specification numbers.

The selection of a reliable supplier, with close attention to his oil and filter element change recommendations can provide satisfactory lubrication and longer life for engines.

DIESEL ENGINE

Use only high quality oils which are:

(1) MIL-L-2104B engine oils (see NOTE).
- or -
(2) Oils which pass the vehicle manufacturer's tests (including General Motors Standard GM 6042M).

NOTE: Supplement 1 engine oils (based upon now obsoleted MIL-L-2104A) have been superseded by MIL-L-2104B engine oils, so these Supplement 1 oils are therefore becoming unavailable.

Where a history of satisfactory performance with Supplement 1 oils has been established, however, they can still be used.

The use of proper engine oils and oil change intervals are your best assurance of continued reliability and performance from GMC engines.

IMPORTANT: Non-detergent and other lower quality engine oils are specifically not recommended in Diesel engines.

GASOLINE ENGINE

Use only high quality oils which are:

(1) Intended for Service Designations "MS" and "DM" (see NOTE).
- or -
(2) Products passing vehicle manufacturer's tests (including General Motors Standard GM 6042M).

NOTE: Supplement 1 engine oils (based upon now obsoleted MIL-L-2104A) have been superseded by MIL-L-2104B engine oils. However, Supplement 1 engine oils ("MS" - "DM") with a history of satisfactory performance are available, and may be used.

The use of proper engine oils and oil change intervals are your best assurance of continued reliability and performance from GMC engines.

IMPORTANT: Non-detergent and other lower quality engine oils are specifically not recommended in gasoline engines.

BREAK-IN OILS AND ADDITIVES

The use of proprietary blends of supplementary additives or concentrates such as engine oil supplements, break-in oils, tune-up compounds, friction reducing compounds, etc., is not recommended in lubricating oils of the diesel engines in GMC truck vehicles.

If greater stability or detergency is desired to reduce varnish and sludge formations, and minimize wear, a thoroughly tested and approved concentrate is available for use in gasoline engines.

ENGINE OIL CHANGE INTERVALS

It is recommended that new engines should have the first oil change at 3,000 miles, or 60 days whichever occurs first. However, the oil level should be checked more frequently during the break-in period since somewhat higher oil consumption is normal until the piston rings become seated.

The kind of oil used (MIL-L-2104B, GM 6042M, etc.), the efficiency of the filtering system and condition of engine must be considered in determining when to change oil.

The most satisfactory method for determining when to change lubricating oil is by oil analysis using laboratory tests.

NOTE: Sample of the engine oil can be obtained from the drain plug on the engine oil filter or Luber-Finer.

After several test periods (gallons fuel consumed, miles, hours, weeks, etc.), a time interval for oil change can be established. However, a new series of tests should be run if filters, oil brands, or grades are changed.

The drain interval may then be increased or decreased, depending upon experience with specific oils or the recommendations and used oil analysis as furnished by the supplier. Such a procedure would be helpful in establishing the most practical oil change period for the particular service.

Wide variations in different types and brands of lubricating oil make it profitable to contact the oil supplier to assist in the development of the oil change period.

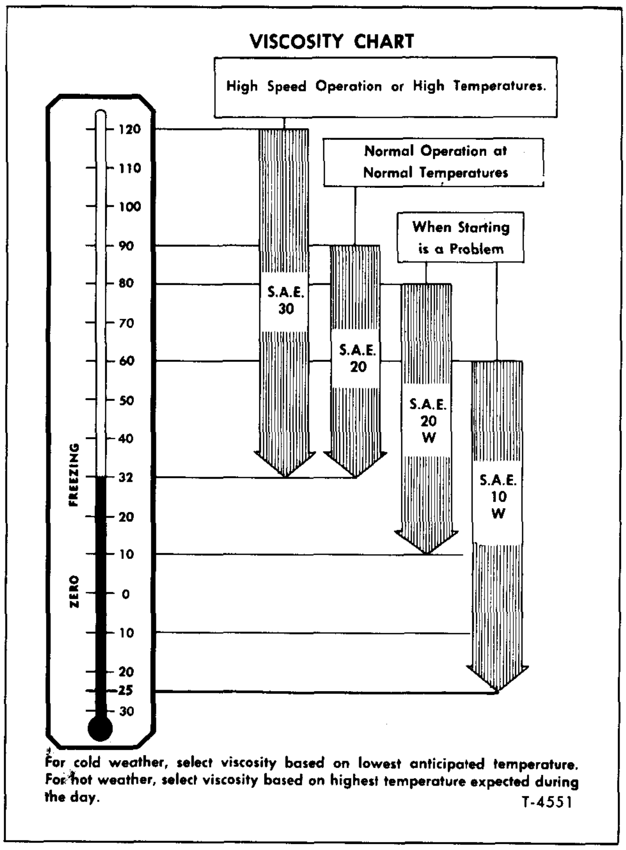


Figure 6—Engine Oil Viscosity Chart (Gasoline)

Filter element or elements should be changed at each engine oil change.

VISCOSITIES

Atmospheric temperatures and severity of service determine the viscosity grade of engine oil to use. Viscosity numbers constitute a classification of lubricants in terms of viscosity or fluidity, but with no reference to any other characteristics or properties.

GASOLINE ENGINES

As a guide to the selection of the proper grade or viscosity of oil to be used in gasoline engines at various atmospheric temperatures, refer to "Viscosity Chart" (fig. 6).

If cold starting is a problem the use of lighter oils will lessen such starting difficulties.

DIESEL ENGINES

S.A.E. 30 engine oil is recommended for year around use. Where cold weather starting is a problem, it is suggested that other starting aids, oil and coolant system heaters (see ENGINE COOLING SYSTEM (SEC. 6K) in this manual), as well as proper fuel selection will be helpful.

Lower S.A.E. engine oil grades (S.A.E. 20, S.A.E. 10, etc.), and the multi-viscosity oils (10W-30, etc.), are not recommended, except as a last resort. If used, they should be replaced with S.A.E. 30 as soon as possible.

MULTI-VISCOSITY TYPE ENGINE OILS

Multi-Viscosity lubricating oils, as a group, are not normally recommended. However, some may be effectively used to facilitate starting when prolonged exposure of the engine to temperatures below freezing is unavoidable. Consult your supplier regarding the performance characteristics of this type of oil and obtain his assurance of adequate lubrication before subjecting the engine to heavy-duty service.

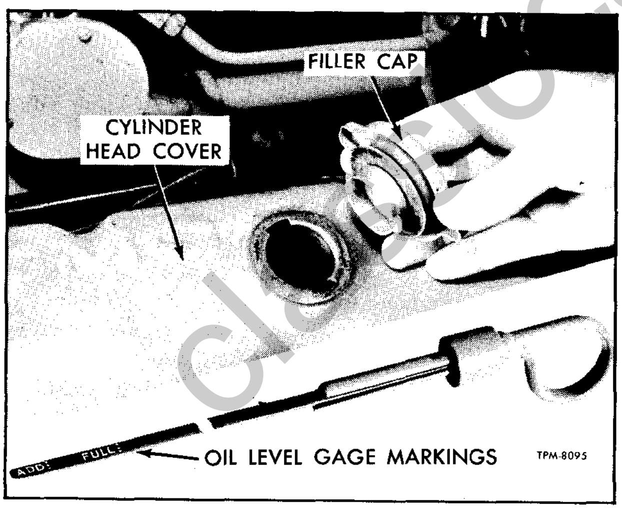


Figure 7—Oil Filler and Dipstick (Gasoline) (Typical)

CHECKING ENGINE OIL LEVEL

Daily, or oftener if necessary, check oil level. Make the check preferably after a day's run and after engine has been stopped for a few minutes. Remove dipstick, wipe clean with cloth, reinsert and remove again. The upper mark on dipstick is "FULL," the lower "ADD." Keep level as close as possible to "FULL" mark without overfilling. Do not operate with level below "ADD" mark.

On gasoline engines, dipstick is on right side and engine can be filled at right filler on valve rocker cover after removing filler cap (fig. 7).

On steel tilt cab models, accessibility is through door behind passenger seat. On other models, dipstick and oil filler are accessible at rear of cab or when hood is raised.

Some vehicles have two oil level dipsticks and two oil filler tubes. Each vehicle has a dipstick and oil filler tube which is accessible by opening the small door to the left of the "GMC" emblem on the front of the cab (fig. 8). The main purpose of this location is to permit checking of oil level and adding oil, if necessary, without having to tilt the cab.

A second oil level dipstick is located at the left front of engine between the two filters (V8-71) and on left side near rear of engine (In-Line 71).

A second oil filler tube is located at the rear of the engine (V8 and In-Line 71).

Daily, or oftener if necessary, check oil level. Make the check preferably after a day's run and after engine has been stopped for at least five minutes.

Remove dipstick, wipe clean with cloth, insert and remove again.

The upper mark on dipstick is "F," the lower mark "L."

Keep level between marks without over-filling.

Do not operate with level below the "L" mark (fig. 9).

ENGINE OIL FILTER

Oil filter element changing periods are closely related to crankcase oil changing periods, the quality of oil used, or the severity of the trucks service. It is recommended that the element be changed initially at first oil change and thereafter at intervals indicated under "Engine Oil Recommendations" for respective engine.

Heavy sludge deposits found on the oil filter elements at the time of an oil change must be taken as an indication that the detergency of the oil has been exhausted. When this occurs, the oil drain interval should be shortened. Since abrasive dust, metal particles and carbon material accumulates in the lubricating oil during engine operation.

ELEMENT REPLACEMENT

1. Remove drain plug from filter housing and drain oil.
2. Loosen filter housing bolt, then remove bolt and housing. Remove element from housing and gasket from filter base.
3. Clean housing thoroughly. Check gasket surface at top of housing for dirt and burrs which might cause oil leaks.
4. Install new element in housing. Fill element housing with oil, unless mounted horizontal. Install gasket in filter base and housing on filter base with filter drain plug away from engine(fig. 10).Tighten housing retaining bolt to 40-50 foot-pounds torque.

NOTE: Some models may have filter mounted horizontal and cannot be filled with oil before mounting.

5. Start engine and operate at idle speed for a few minutes until oil pressure has built up to normal. Check filter for leaks, then check dipstick level. Add oil to bring level up to (not above) "F" mark on dipstick.

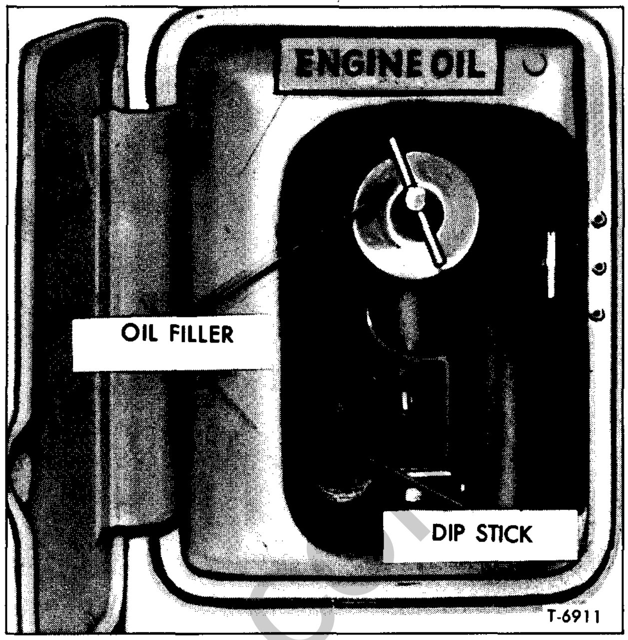


Figure 8—Oil Dipstick and Filler Tube (Front) (Alum. Tilt)

LUBER-FINER UNIT

DESCRIPTION

The "Luber-Finer" engine oil filter is installed on some vehicles (fig. 11). This unit is used as

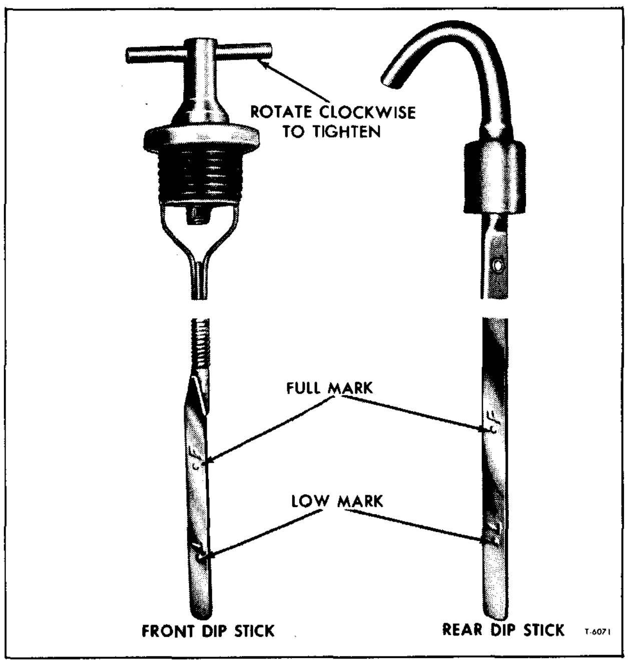


Figure 9—Oil Level Dipsticks (Alum. Tilt)

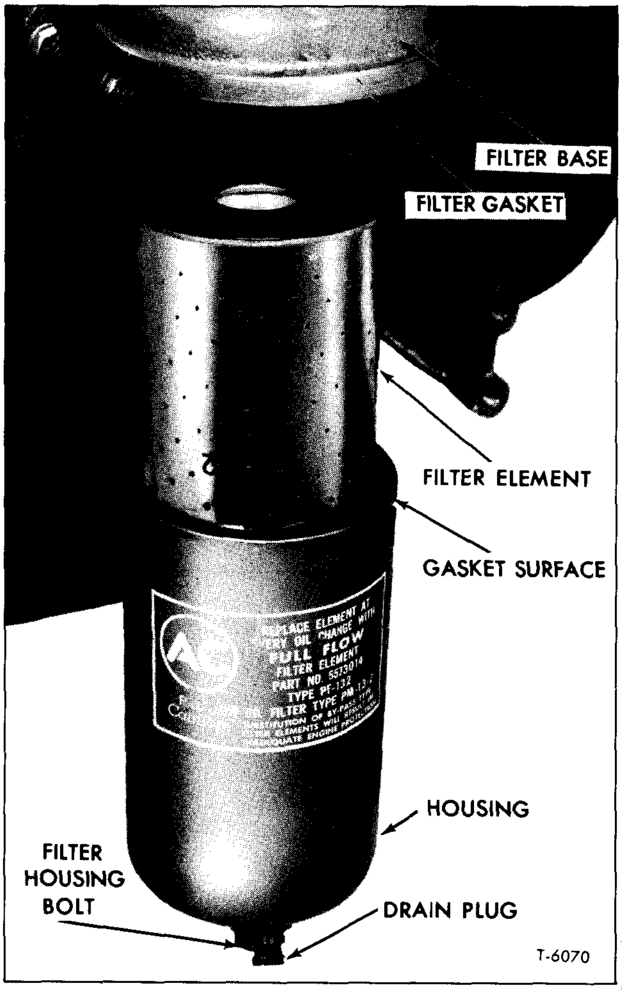


Figure 10—Oil Filter Element (Typical)

a partial-flow (by-pass) filter, and is connected to bleed oil through a restricted orifice from the engine pressure system through the filter element, returning the filtered oil to engine oil pan.

ELEMENT REPLACEMENT (Fig. 11)

NOTE: Element should be replaced at each oil change.

1. Open vent plug, open drain cock to drain oil.

NOTE: Drain hose can be turned with the drain cock. Level of oil in filter should be below cover clamp ring before cover is removed.

2. Loosen cover clamping ring bolt, then remove clamping ring. Remove cover and gasket from housing. Turn element hold-down assembly counterclockwise, then remove and discard element.

IMPORTANT: ALWAYS use specified Luber-Finer element for full efficiency performance.

3. Clean inside of housing and cover with cleaning solvent. Make sure all solvent is removed.

NOTE: Change engine oil and filter in regular manner.

4. Check orifice and bleeder hole (fig. 11) to see that they are open.

5. Install new element in housing. Secure element with hold-down assembly. Tighten hold-down against stop.

6. Install new gasket if necessary, cover and clamp ring. Tighten clamp ring until it stops against shoulder.

IMPORTANT: Extra oil must be added in addition to the normal capacity of the system to fill the Luber-Finer as follows:

Model	Capacity	Luber-Finer Element Part No.	Element Part No.
500C	2½ Gallons	2122	2333078
750C	3½ Gallons	2095	2455358

7. With engine crankcase filled to normal oil capacity ("FULL" mark on dipstick), start and run at idle speed for 60 seconds maximum. Do not permit oil to spill excessively from vent opening. Stop engine and add slightly less than specified capacity of oil for size of Luber-Finer used.

NOTE: Additional oil can be added later.

8. Start engine and run at idle. If necessary, run engine until air is bled out of Luber-Finer vent valve (fig. 11). Tighten vent valve and run engine approximately five minutes.

9. Check engine oil level in prescribed manner and, if necessary, bring level to "FULL" mark.

IMPORTANT: DO NOT OVER-FILL ENGINE.

OTHER ENGINE OIL USES

DISTRIBUTOR

Breaker Pivot. Remove distributor cap and apply one drop of S.A.E. 10 engine oil to breaker arm pivot. Do not apply excessive lubricant.

Shaft. Shaft is lubricated by hinge cap oiler. Fill cup with S.A.E. 20 engine oil.

Rotor Felt. A felt is used under rotor of some distributors. Apply 3 or 4 drops of S.A.E. 20 engine oil.

STARTER

Some starters are equipped with oiler or plug at drive end, plug at commutator end, and plug at middle bearing. At time of installation, apply S.A.E. 20 at plugs or oilers.

LINKAGE

Engine oil is used also to lubricate clevis pins, linkage, clevises, etc. Application should be made by brush or spray.

AXLE SHIFT UNIT

Remove plug in cover and fill to level of opening with S.A.E. 10 engine oil.

AIR CLEANERS

Some air cleaners require engine oil for servicing. Refer to ENGINE FUEL SYSTEM (SEC. 6M) of this manual for information on servicing. As a rule the same type and viscosity of engine oil is used in the air cleaner as in the engine.

CRANKCASE VENTILATION

GASOLINE ENGINES

The positive crankcase ventilation system makes an important contribution to the reduction of air pollution by recycling fuel fumes, which enter the crankcase back to the combustion chamber to be burned, and achieves nearly one-hundred per cent elimination of crankcase emissions, one-third of the total hydrocarbon emissions from a vehicle.

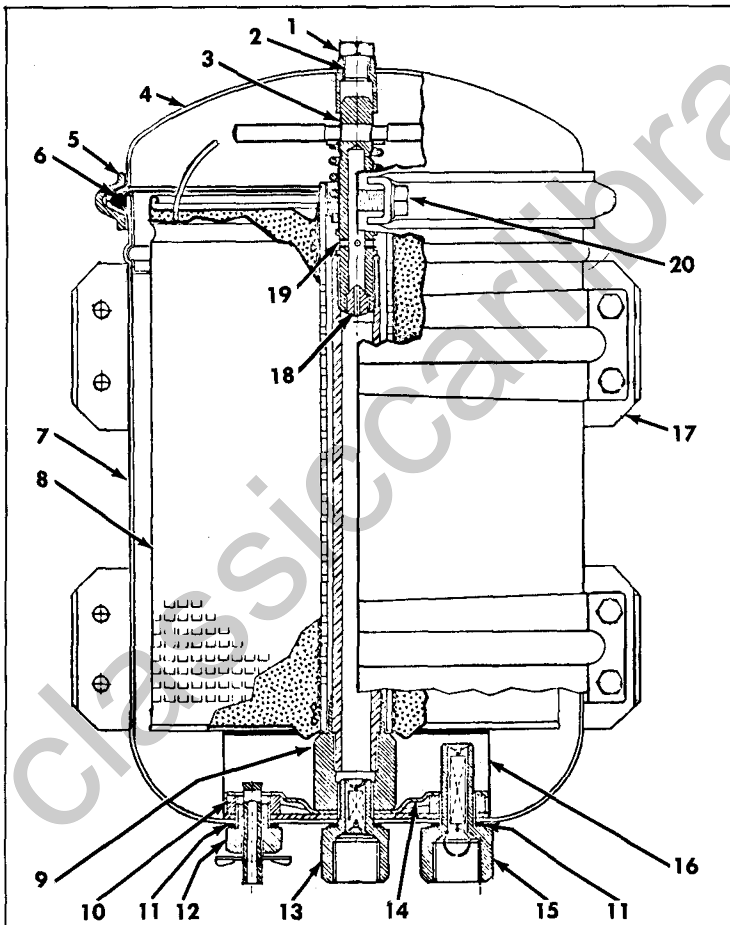
A ventilation valve is threaded into each cylinder head. When valves open, crankcase fumes are drawn into combustion chamber to be burned, thereby eliminating discharge from crankcase into air and reducing pollution.

At the first engine oil change the ventilation valve(s) should be checked for proper operation as described in GASOLINE ENGINES (SEC. 6A) under crankcase ventilation system. Every 12,000 miles, or 12 months, whichever occurs first, the valve(s) should be replaced.

A crankcase breather (fig. 12) is installed at valve rocker arm cover and should be removed and cleaned at each oil change interval.

V6-53 SERIES DIESEL (Fig. 13)

It is recommended that the breather tube be inspected and cleaned, if necessary, to eliminate the possibility of clogging. This can best be done by removing the tube from engine (fig. 7), washing



1 Vent Plug Cap Screw
2 Washer, Aluminum (Vent Plug Seal)
3 Pack Hold-Down Assembly
4 Cover
5 Clamping Ring Assembly
6 Cover Gasket
7 Housing
8 Element
9 Outlet Tube and Nut Assembly
10 Nut (Inlet and Drain Fitting)
11 Washer, Aluminum (Inlet, Outlet, Drain)
12 Drain Cock
13 Outlet Check-Valve Assembly
14 Retainer
15 Inlet Check-Valve Assembly
16 Pack Support
17 Mounting Bracket Assembly
18 Orifice Plug
19 Bleeder Holes
20 Clamp Screw

Figure 11—Luber-Finer Unit

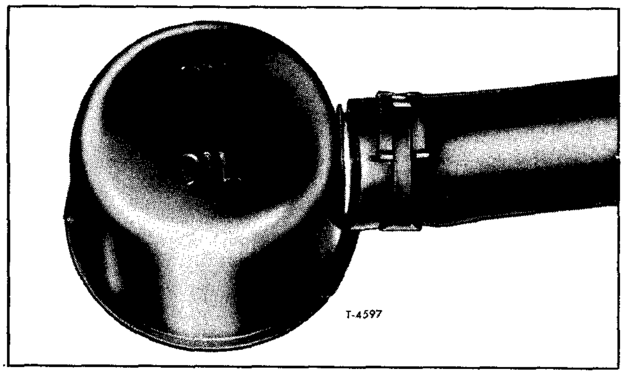


Figure 12—Crankcase Breather (Gasoline)

it with a suitable solvent and drying it with compressed air.

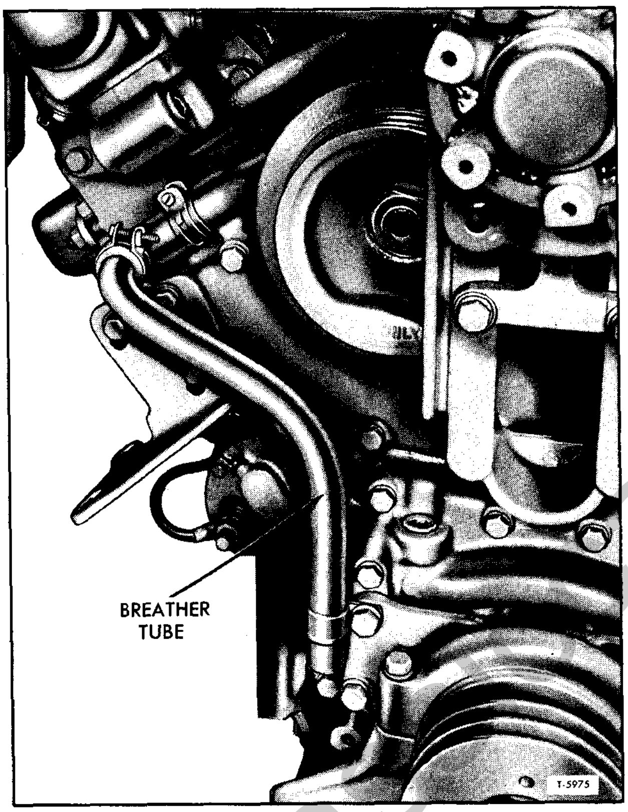


Figure 13—Crankcase Ventilation System (6V-53 Engine)

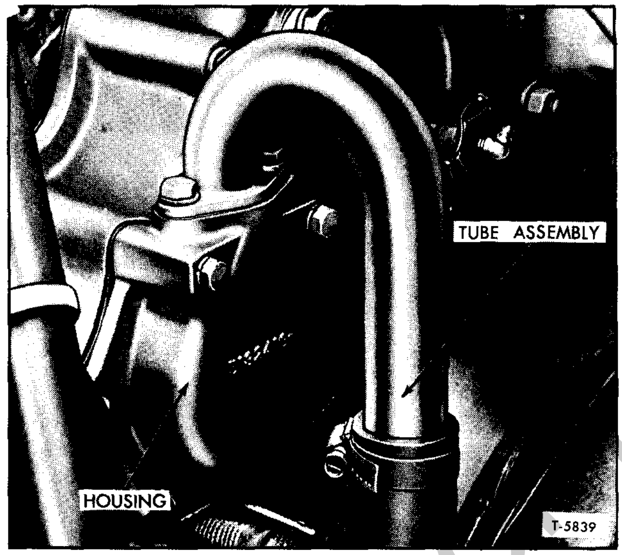


Figure 14—Crankcase Ventilation System (V8-71 Engine)

The wire mesh pad (element) in the breather assembly should be cleaned if excessive crankcase pressure is observed. If it is necessary to clean the element, remove the upper front cover.

Wash the element in fuel oil and dry it with compressed air.

Reinstall the element and upper front cover in same manner as removed.

SERIES 71 ENGINES

Crankcase ventilation is accomplished through a breather pipe which expels vapors from within the crankcase. Breather tube on 6-71 engines is attached to governor and requires no periodic maintenance.

Crankcase ventilation on V8-71 engines (fig. 14) is accomplished by a breather, separator and tube assembly which is attached to opening in flywheel housing. Every 30,000 miles the assembly should be removed and disassembled and steel mesh removed for cleaning. Immerse all parts in fuel oil or cleaning solvent to remove all accumulations of oil and foreign matter.

MULTI-PURPOSE GEAR OIL (SYMBOL "MPO" ON CHARTS)

Multi-Purpose Gear Oil, meeting U.S. Army Ordinance Specification MIL-L-2105B and/or A.P.I. -GL-5 and indicated by the Symbol "MPO" on charts, must satisfactorily lubricate heavy duty truck hypoid or bevel axles, and transmissions, under maximum torque and speed conditions. It must provide necessary and suitable load-carrying characteristics to prevent scoring and wear, good stability in storage and service, and give good resistance to corrosion. Suppliers should assure these characteristics, and be responsible for the quality and satisfactory performance of their products.

VISCOSITIES

ROCKWELL AXLES

In Rockwell axles, S.A.E. 140 should be used the year around except in cases of extremely low temperatures. If trucks are parked in temperatures below $+20^{\circ}$F., or operated in temperatures consistently below 0°F., it is advisable to use S.A.E. 90.

OTHER UNITS

S.A.E. 90 may be used the year around. If truck is operated in temperatures consistently below 0°F., use S.A.E. 80. If the truck is operated in consistently high temperatures (over 100°F.), S.A.E. 140 may be used.

REAR AXLE

CHECKING LEVEL

Remove filler plug and if necessary, add sufficient oil to bring level up to filler plug level. Install and tighten plug.

DRAINING AND FILLING

When axle is new, or after overhaul, it is recommended that oil be drained after the first 3,000 miles of operation, and thereafter at recommended intervals. Draining at an early mileage remove fine particles of metal or other foreign material.

At specified intervals remove plug at bottom of axle housing, also at bottom of inter-axle differential housing on tandem bevel axles. Drain when unit is hot, preferably immediately after operation. Reinstall drain plugs.

Fill axle to level of filler plug opening. On tandem axles add two pints of lubricant at top of inter-axle differential housing.

SPECIAL AXLE LUBRICATION

Special lubrication is required on all axles as follows: (1) when axle has not been operated for a long period (2) when axle has been out of normal position or (3) after overhaul.

Add one pint of lubricant through plug opening in top of pinion cage or differential carrier. Recheck lubricant level at filler plug.

WHEEL BEARINGS (OIL LUBRICATED)

Wheel bearings are sometimes lubricated by gear oil instead of wheel bearing grease.

NOTE: Refer to "Gear Oil" for front wheel bearing lubrication.

REAR WHEELS

1. Rotate wheel until pipe plug in axle shaft flange is at bottom. Vehicle on level surface.
2. Clean area around plug, then remove plug.
3. If oil is below pipe plug fill to level of plug opening with same Multi-Purpose Gear Oil used in rear axle.

NOTE: DO NOT FILL ABOVE PLUG OPENING.

4. Install and tighten pipe plug.

NEW PROCESS TRANSMISSION

CHECKING LEVEL (Fig. 15)

At specified intervals remove filler plug at side of case and, if necessary, add sufficient recommended oil to bring lubricant level up to level of opening. Install and tighten filler plug.

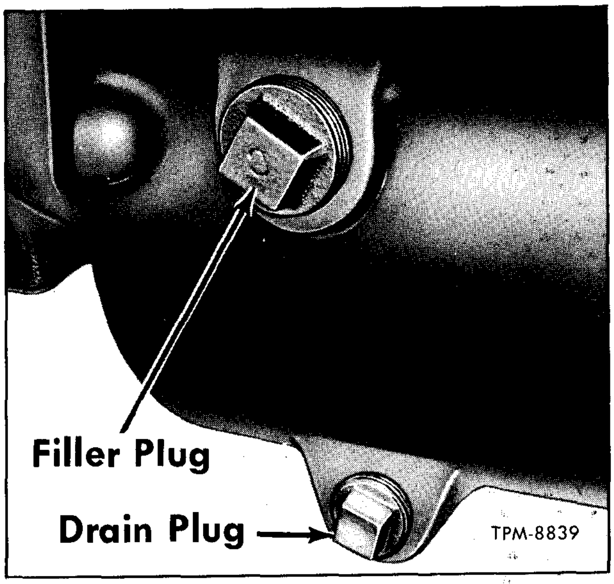


Figure 15—Drain and Filler Plugs (Typical Transmission)

DRAINING AND FILLING (Fig. 15)

When transmission is new, or after overhaul, it is recommended that oil be drained after the first 3,000 miles of operation, and thereafter at recommended intervals. Draining at early mileage removes fine metal or other foreign material.

At specified intervals, preferably immediately after operation while unit is hot, remove plug to drain lubricant. Clean drain plug, then reinstall and tighten securely. Refill to level of filler plug opening as directed above. Use S.A.E. 90 the year around.

GEAR OIL (SYMBOL "GO" ON CHARTS)

Type of lubricant indicated by the symbol "GO" on charts must be straight mineral gear oil of the best quality. Oxidation inhibitors or anti-foam agents may be added to these oils to gain greater stability and resistance to thickening.

CLARK TRANSMISSION

Method of checking level, draining, and filling Clark transmission is the same as previously described under "Multi-Purpose Gear Oil" heading. In addition, a magnetic plug is located at left upper front side of case which must be removed and cleaned at regular drain intervals. Use S.A.E. 90 above 0^{O}F., or S.A.E. 80 when temperature is below 0^{O}F.

FULLER TRANSMISSION

Transmission has one drain plug at bottom and one filler plug at left side (fig. 16)

CHECKING LEVEL

Remove filler plug from left side. If necessary, add sufficient lubricant to bring level up to filler plug opening. Use S.A.E. 90 above $+10^{O}$F., or S.A.E. 80 below $+10^{O}$F. Install and tighten filler plug.

DRAINING

When new or after overhaul, drain lubricant at 3,000 miles, thereafter at recommended intervals. Remove drain plug at bottom of case when unit is hot, preferably immediately after operation. Install drain plug. Remove filler plug and add lubricant to level of plug opening. Install and tighten filler plug.

WHEEL BEARINGS (OIL LUBRICATED)

Front wheel bearings are sometimes lubricated by gear oil instead of wheel bearing grease.

NOTE: Refer to "Multi-Purpose Gear Oil" for rear wheel bearing lubrication.

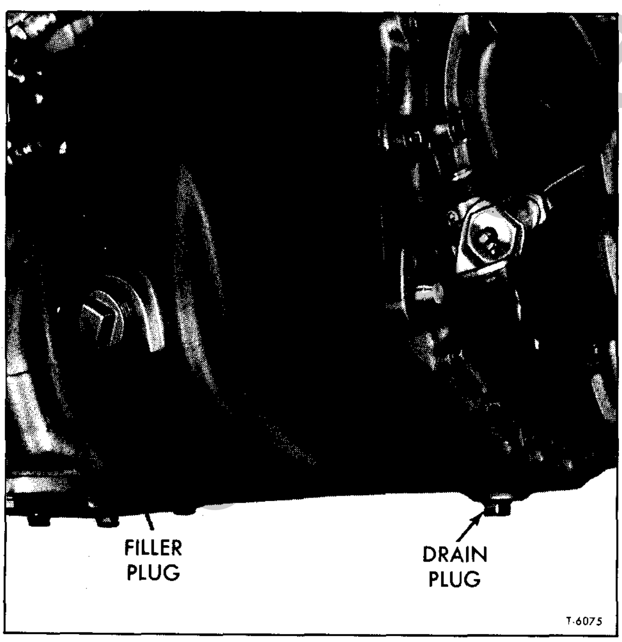


Figure 16—Drain and Filler Plugs (Fuller Transmission)

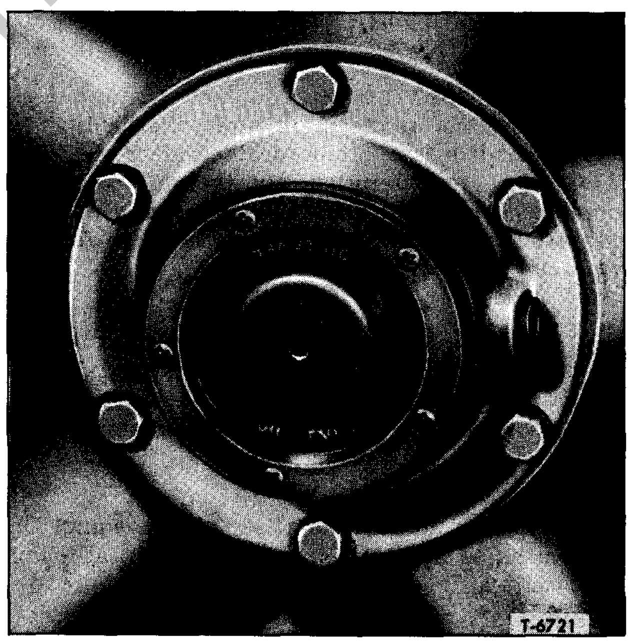


Figure 17—Oil Lubricated Front Wheel Bearings

FRONT WHEEL

1. Rotate wheel until "OIL LEVEL" (fig. 17) is at bottom.
2. If oil is below level mark remove pipe plug (fig. 19).
3. Fill to "OIL LEVEL" mark with S.A.E. 90 Straight Mineral Gear Oil.

NOTE: DO NOT FILL ABOVE LEVEL MARK.

4. Install pipe plug.

LUBRICATING OIL—SPECIAL (SYMBOL "ES" ON CHARTS)

Oils such as "Aviation Grade Engine Oil" or S.A.E. 50 Heavy Duty engine oils may be used. Use of S.A.E. 30 is recommended when temperature falls below 32°F.

SPICER TRANSMISSION

The type of oil indicated by the symbol "ES" on charts for use in Spicer transmissions must be an S.A.E. 50 engine oil of good quality.

CHECKING LEVEL

At specified intervals remove filler plug at side of case, and if necessary, add sufficient recommended lubricant to bring lubricant level up to level of filler plug opening. Install and tighten filler plug.

DRAINING AND FILLING

When new, or after overhaul, it is recommended that lubricant be drained and refilled at the first 3,000 miles, and thereafter at intervals indicated on charts.

At specified intervals, preferably immediately after operation while unit is hot, remove drain plug at bottom of case to permit lubricant to drain. Refill to level of filler plug opening as directed above. Replace filler plug.

NOTE: On Spicer compound transmissions, remove two drain plugs, one each in forward and rearward housings.

MULTI-PURPOSE GREASE (SYMBOL "MPG" ON CHARTS)

The lubricant indicated by the symbol "MPG" on charts should be a high temperature, good quality lithium soap, multi-purpose, extreme pressure grease, which meets GM Specification GM 6031M.

LUBRICATING CHASSIS

All lubrication fittings must be clean before applying lubricant. Also, always be sure equipment used in applying lubricant is clean. Every precaution should be taken to prevent entry of dirt, grit, lint, or other foreign matter into lubricant containers.

NOTE: Fittings that have become broken, or damaged, should always be replaced with new part, and can be removed with a wrench or suitable extracting tool.

UNIVERSAL JOINTS

At specified intervals, use pressure gun to apply lubricant through fitting in universal joint trunnion (fig. 18) To ensure proper lubrication of all four trunnion bearings, it is important that lubricant be added until it appears at all four journal bearing seals fig. 18) . It should not be assumed that bearings are lubricated unless lubricant is observed coming from around all four bearing seals. However, if lubricant does not appear at all seals, move the universal joint trunnion in all four directions while applying lubricant under pressure.

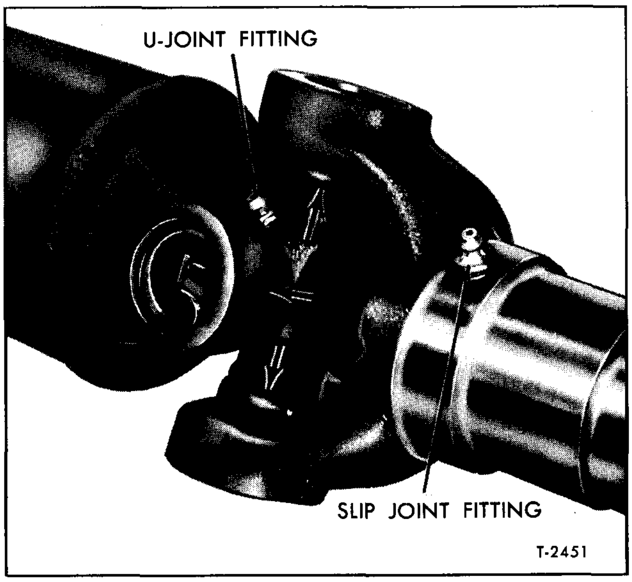


Figure 18—Universal and Slip Joint Lubrication

WHEEL BEARINGS

All wheel bearings (except oil lubricated type) require high temperature grease. Instructions for the adjustment of wheel bearings will be found in "FRONT HUBS AND BEARINGS" (SEC. 3D) of this manual.

CLEANING

With a stiff bristle brush and cleaning solvent, thoroughly clean bearings and hubs, making sure that all old lubricant and dirt is removed. Check bearings and cups, replace damaged parts.

PACKING

Some wheel bearings are lubricated from axle differential after the initial lubrication. However, whenever wheel hub is removed, bearings should be cleaned, inspected, and re-lubricated. Some rear wheel bearings require cleaning, inspection, and lubrication at regular intervals as specified on lubrication charts.

When packing by hand, be sure that lubricant is kneaded between rollers and races. A mechanical lubricator can be used; however, bearings must be thoroughly lubricated.

DO NOT FILL HUB. Coat inside hub and axle spindle with thin coat (1/8" thick) of grease to retard rusting. Allow some excess grease at inner side of bearings and around adjusting nut. DO NOT PACK HUB WITH GREASE. The lubricant applied to bearings is sufficient to provide lubrication until next service period. Readjust bearings as described in "FRONT HUBS AND BEARINGS" (SEC. 3D) or "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

STEERING GEAR LUBRICANT (SYMBOL "SG" ON CHARTS)

The lubricant indicated by the symbol "SG" is a special steering gear lubricant, No. 0 grade with low cold test characteristics and extreme pressure properties. This type of lubricant is marketed by many oil companies.

Multi-Purpose oil "MPO" previously described, may be used to replenish steering gear housing when additional lubricant is required; however, lubricant as described previously must be used as initial fill after overhaul, or in a new gear.

At specified intervals, remove filler plug in housing and add lubricant to bring level up to filler plug opening. Do not overfill housing.

When hard steering is encountered as a result of cold weather, the steering system should be lubricated as follows:

Use steering gear lubricant (Symbol "SG") or Multi-Purpose Grease (N.L.G.I. #0) to lubricate all steering linkage such as steering knuckles, tie rod ends, drag link ends, and (if used) power steering booster cylinder ends.

PETROLEUM JELLY (SYMBOL "S3" ON CHARTS)

The type lubricant indicated by the symbol "S3" is petroleum jelly or petrolatum.

DISTRIBUTOR BREAKER CAM

At recommended intervals, apply a small amount of petroleum jelly on distributor breaker cam. Do not use an excessive amount.

BATTERY TERMINALS

To prevent corrosion, remove cables, clean terminals on cable and battery, and reinstall the cables to battery terminals. Tighten the cables securely, then apply petroleum jelly.

WATERPROOF GREASE (SYMBOL "S4" ON CHARTS)

This type of lubricant should be waterproof grease containing 20 to 35 per cent calcium soap. On models equipped with propeller shaft center bearings, both sides of the shield should be packed with this lubricant at the time of assembly. This lubricant excludes water and dirt from bearing.

Lubricants Must Be Stored and Dispensed in Such a Manner That They Will Be Clean and Free of Contamination, Due to Dirt or Other Foreign Matter.

HYDRAULIC BRAKE FLUID (SYMBOL "S12" ON CHARTS)

The fluid indicated by the symbol "S12" must be genuine heavy duty brake fluid meeting the heavy duty standards of S.A.E. J-1703.

CLUTCH AND BRAKE MASTER CYLINDER

Check master cylinder fluid level at intervals indicated on charts. Remove dirt from around the plug or cover; then remove.

Fill with fluid until level is within ½" of opening. Inspect to be sure vent hole is clean, then install and tighten filler plug or cover (refer to (fig. 20)

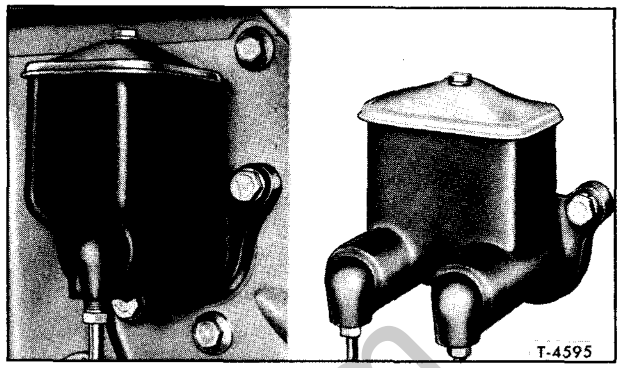


Figure 19—Clutch and Master Brake Cylinder (Typical)

SPECIAL GREASE (SYMBOL "S17" ON CHARTS)

A semi-fluid grease having extreme pressure properties and containing zinc oxide.

At regular lubrication intervals, or whenever accessible during repairs or overhaul, apply lubricant sparingly to the following items and areas:

- Door Striker Plates
- Door Checks and Trunnions
- Door Hinge Pins
- Door Lock Remote Control Link
- Cowl Ventilator Linkage
- Seat Adjuster Slides
- Door Striker Bolts
- Door Lock Plunger
- Door Lock Mechanism
- Door Dovetails
- Window Regulator Channels
- Window Regulators
- Hood Hinges
- Tilt Cab Release Mechanism
- Speedometer Cable

In addition to above items, which are lubricated periodically, many other units use this lubricant at time of assembly after overhaul, as indicated in various sections of this manual.

AUTOMATIC TRANSMISSION FLUID (SYMBOL "S19" ON CHARTS)

General Motors DEXRON® Automatic Transmission Fluid, Part No. 1050568-69-70 which has been especially formulated and tested for use in automatic transmissions is recommended for use in power steering system. Other automatic transmission fluids identified with the mark DEXRON® are also recommended.

POWER STEERING SYSTEM

Power steering system reservoir is located on left rear of engine (fig. 20 or 21). Reservoir shown in figure 20 incorporates a sight glass and fluid level should be kept just above sight glass. Reservoir shown in figure 21 is marked with an "OIL LEVEL" mark. Use "Automatic Transmission Fluid GM DEXRON ®."

NOTE: DO NOT USE HYDRAULIC BRAKE FLUID, SHOCK ABSORBER FLUID, OR SIMILAR OIL.

After cleaning reservoir and cover, loosen cover and remove. Using a clean receptacle, pour fluid through a 200-mesh screen - NOT A CLOTH STRAINER. Keep fluid clean and free from water.

For cold weather preparation on steering gear refer to information under "Steering Gear Lubricant" (Symbol "SG" on Charts).

Whenever a line is disconnected or a pump is replaced, the air that has entered the hydraulic system must be bled out, otherwise noisy and unsatisfactory operation will result. Refer to "POWER STEERING" (SEC. 9B) in this manual for bleeding the system.

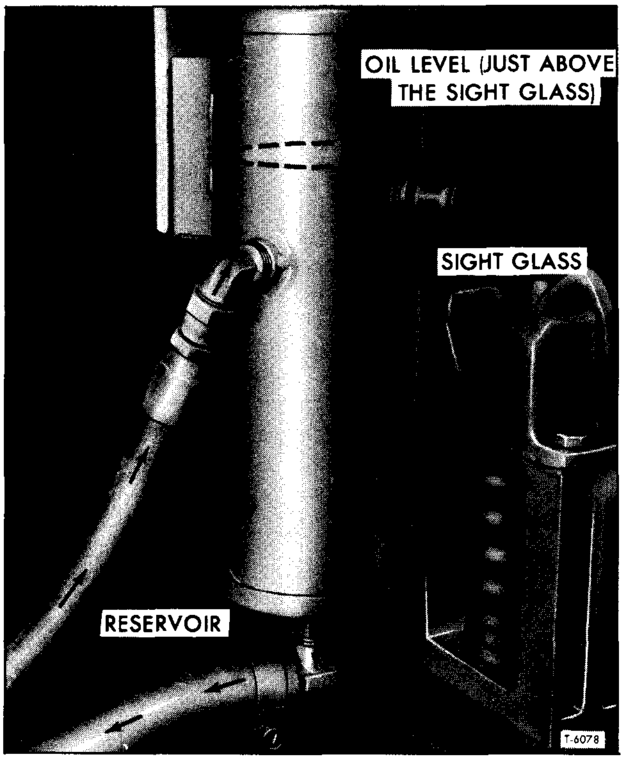


Figure 20—Power Steering Reservoir

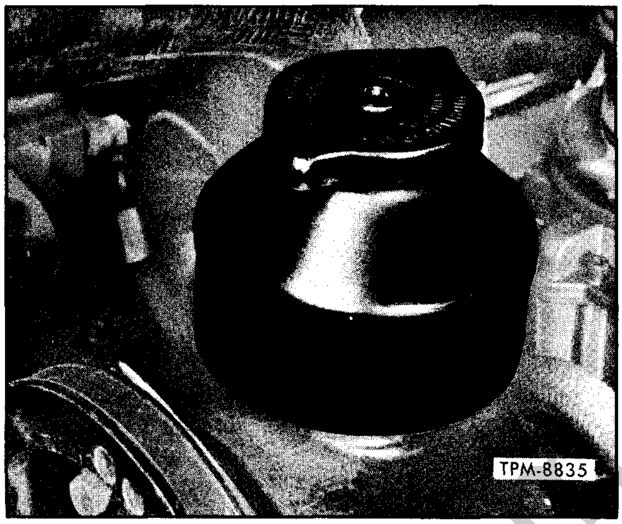


Figure 21—Power Steering Reservoir (Typical)

ALLISON AUTOMATIC TRANSMISSION

Allison transmission is filled with recommended Automatic Transmission Fluid (GM DEXRON®) at the factory. DO NOT MIX TYPES OF FLUID.

CHECKING FLUID LEVEL

IMPORTANT: Transmission oil level should be checked at least every 1,000 miles, or more often. If oil level is too high or too low, foaming of oil will occur. This will affect lubrication, cooling, and pressure build-up.

NOTE: Dipstick and filler tube are located at right side.

1. Apply parking brake firmly and block wheels. Start engine and warm fluid to operating temperature.

IMPORTANT: DO NOT operate retarder while warming fluid. Move selector lever through all speed ranges.

2. Run engine at idle rpm with lever in "N" (Neutral).
3. Clean dipstick and adjacent area, then remove dipstick, clean, reinsert, again remove and note fluid level.
4. Add one quart of fluid when level reaches "ADD" mark.

DRAINING AND FILLING

When new or after overhaul, drain fluid and change filter element after 3,000 miles, thereafter at 12,000 mile intervals. Drain while fluid is at operating temperature (160°F. min.).

1. Remove bolt, nut, and strap which secures filter cover to oil pan.
2. Carefully remove filter cover to prevent oil "gushing" out. When drainage is complete, remove cover and filter element.
3. Install new element, retainer seal ring, and cover seal ring. Secure cover-to-oil pan with strap. Tighten strap retaining bolt to 11 to 14 foot-pounds torque.
4. Pour nine quarts of specified oil into transmission.
5. Start engine and check fluid level. DO NOT OVERFILL.

IMPORTANT: Transmission refill fluid capacity, after various service operations have been performed, is as follows:

a. Removal of filter cover only - approximately 9 quarts.
b. Removal of oil pan only - approximately 10 quarts.
c. Removal of oil pan and control valve assembly - approximately 13 quarts.
d. If transmission (including converter) and oil cooling system have been completely drained - approximately 19 quarts.

OIL COOLER, LINES, AND BYPASS SYSTEM

IMPORTANT: The vehicle's radiator not only cools the engine coolant, but also cools the transmission oil. It is imperative that the coolant be at the proper level at all times, otherwise insufficient heat dissipation from transmission oil will result.

An oil cooler located in the bottom of the radiator, through which transmission oil is circulated before returning to the oil pan, dissipates heat created by normal operation of the torque converter and transmission. If a transmission failure occurs which causes foreign matter to be carried into the oil cooler, the cooler and all connecting lines should be thoroughly cleaned by flushing before transmission is put back into operation.

FLUSHING OIL COOLER AND LINES

It is important that following transmission malfunctions, the transmission oil cooler be properly flushed since foreign particles lodged in the cooler eventually become free and can cause a repeated transmission failure. If oil cooler and lines are properly flushed, the possibility of reoccurrence of these troubles after transmission has been repaired is eliminated or substantially reduced.

Whenever an internal difficulty occurs in the transmission which would result in clutch plate material or metal particles being distributed throughout the oil system, the oil cooler should be thoroughly flushed as outlined in the following text, then an auxiliary filter installed in the cooler return line before the vehicle is returned to service.

a. Disconnect both oil cooler lines at the fittings at side of transmission case, or if an auxiliary filter has been previously installed, disconnect cooler return line at filter instead of at transmission. (Change auxiliary filter element.)

b. Back-flush the oil cooler and lines using clean solvent and compressed air.

CAUTION: DO NOT EXCEED 100 PSI AIR PRESSURE.

c. Remove all remaining cleaning solvent from the system with compressed air.

d. Flush the cooling system again with DEXRON® transmission fluid. After the final flush, test the oil cooler for free flow of oil, and if the flow is restricted, the radiator bottom tank and cooler assembly must be replaced.

HYDRAULIC OIL (SPECIAL) (SYMBOL "S23" ON CHARTS)

The fluid indicated by the symbol "S23" is a special hydraulic fluid meeting MIL-H-5606B specification, or equivalent, which is satisfactory for use in cab hydraulic hoisting equipment.

CAB HYDRAULIC HOIST

Cab hydraulic hoist fluid reservoir is attached to pump at frame right side rail. Reservoir has a filler plug with a tab marked "FILL HERE" and a pressure relief valve. Fluid reservoir should be kept full.

TO CHECK FLUID

Thoroughly clean top of pump reservoir around filler plug. Remove plug, then add to reservoir until full; replace and tighten plug.

NOTE: Cab must be in "DOWN" position. Refer to "ALUMINUM TILT CABS" (SEC. 1D) in this manual for instructions.

HIGH TEMPERATURE GREASE (SPECIAL) (SYMBOL "S27" ON CHARTS)

The lubricant indicated by the symbol "S27" on charts should be a short fiber, non-fluid, sodium soap grease having a high melting point (500°F.), and having a #3 N.L.G.I. consistency.

CLUTCH RELEASE BEARING

Mileage interval shown on charts may be altered to meet type of service or driving conditions. Stop and go (city) driving requires more frequent use of clutch release mechanism, and consequently should be serviced at more frequent intervals than a vehicle which is operating in highway service.

Use extreme caution not to over-lubricate the bearing, although the interval of application should not exceed 6,000 miles. Use caution, when applying lubricant, not to overlubricate or use excessive pressure, as excess grease may reach clutch facings and result in serious clutch problems.

Clutch release bearing fitting is accessible by removing the flywheel or clutch housing inspection cover. Some vehicles use a grease cup which is accessible at side of clutch housing.

OTHER HIGH TEMPERATURE GREASE USES

The following points require use of high temperature grease at assembly. Methods of applying grease to these points are covered in applicable sections of this manual.

Clutch Release Bearing Collar
Clutch Shift Fork Ball Stud
Steering Column Upper Bearing

HIGH TEMPERATURE GREASE (SPECIAL) (SYMBOL "S28" ON CHARTS)

The lubricant indicated by the symbol "S28" must be a water-proof, non-soap, smooth fiber grease having a #1 N.L.G.I. stable consistency, and must withstand extended high (500°F.) temperatures. A grease containing Bentonite or equivalent should be satisfactory.

STOPMASTER BRAKE UNIT

At time of assembly after overhaul apply above lubricant to areas indicated in "AIR BRAKES" (SEC. 5B) of this manual.

IMPORTANT

The use of proper engine oils and oil change intervals are your best assurance of continued reliability and performance from your GMC engine.

IMPORTANT

Lubricants Must Be Stored and Dispensed in Such a Manner That They Will Be Clean and Free of Contamination, Due to Dirt or Other Foreign Matter.

SECTION 1
CAB AND BODY MOUNTINGS

Contents of this section are listed in Index below:

Information on sheet metal and fiberglass components as used with Conventional Cab is described in SHEET METAL AND FIBERGLASS (SEC. 11) of this manual. Description of each type cab is explained in respective cab section.

Maintenance information on subjects common to all cabs, such as painting, checking for water and dust leaks, correcting cab alignment, windshield wipers, and replacement of windshield glass is covered in the "GENERAL CAB MAINTENANCE" section following. For all other information, refer to respective cab section.

For information pertaining to cab wiring and dash gauges, refer to CHASSIS ELECTRICAL AND INSTRUMENTS (SEC. 12) of this manual. A wiring diagram of electrical system is provided beneath center console access panel on Alum. Tilt models.

GENERAL MAINTENANCE

NOTE: This section includes general maintenance information on subjects which are common to all cabs. Subjects are listed in Index below:

NOTE: Refer to respective CAB section for all other information.

GENERAL

Regular periodic inspections and maintenance procedures are recommended to ensure that all cab mounting bolts are kept properly tightened.

Keep door hinge bolts tight - both those attaching hinge to body, as well as bolts which attach hinge to door.

Periodically check all cab bolts for tightness.

Proper protection and maintenance of finish will add to its luster. Road elements are injurious to painted surfaces of vehicles. These can be removed by regular washings. As an additional protection, polish vehicle, using a good grade of wax, 30 days after delivery. Apply a coat of polish thereafter at least once a year.

An application of DC4X silicone or equivalent to door weatherstrip and adjacent contact areas on cab will prevent squeaks and freezing of weatherstrip to cab.

Refer to SHEET METAL AND FIBERGLASS (SEC. 11) for fiberglass repair information.

EXTERIOR MAINTENANCE

Aluminum is attacked by many acids and most alkalies. Consequently, considerable care should be taken in the selection of chemical cleaners. Use of even inhibited-type alkaline cleaners is inadvisable due to difficulty in removing all traces of cleaner. Therefore, it is recommended that painted and plated external finishes be cleaned only with soap and water.

Body painted surfaces and chrome plating should be protected by a coating of wax applied at regular intervals. Periods between applications should be sufficiently short to assure continuous protection of the finish; 30 days after delivery and at least once a year thereafter. Any good body wax can be used for both painted and chrome surfaces. Wax should be applied immediately after vehicle has been cleaned and be rubbed down with a lamb's wool polishing wheel or by hand.

The entire vehicle should be regularly inspected for corrosion and paint damage. Particular attention should be given to chrome and exposed aluminum surfaces during the winter months. Since aluminum is susceptible to attack by alkaline substances, road de-icing materials such as salts and chlorides accelerate corrosion of exposed aluminum parts. If inspection reveals corrosion or paint damage, corrective measures should be immediately employed as described later in this section.

INTERIOR CLEANING

Care of upholstery and interior panels is a relative simple but important matter. Accumulation of dirt eventually turns into a hard, gritty, substance which eventually penetrates fabric and spoils appearance.

VINYL COATED CLOTH

To clean seats, door panels, dash padding, sleeper compartment panels, and engine tunnel cover, use lukewarm water with a mild liquid household soap. Work up thin suds on a piece of cheesecloth, rub upholstery briskly but lightly. Remove suds with a clean damp cloth and finish by wiping lightly with a dry soft cloth. Do not use furniture polishes, oils, varnishes, or ammonia. As required, stubborn stains may be removed with common foaming-type upholstery cleaner prepared for use on vinyl cloth.

FLOOR CARPETING

Floor should be cleared of debris by sweeping or vacuuming. Soiled areas may be cleaned with ordinary carpet cleaner and a soft bristle brush. Use cleaner sparingly and allow area to dry thoroughly.

WINDOW GLASS

Clean window glass and mirrors with a good household window cleaner. Follow manufacturer's directions in proper use of cleaner.

Avoid use of petroleum base cleaners since they will attack rubber and paint finishes. Never wax windows, vinyl coated cloth, or painted non-reflective surfaces such as dash or console.

DUST AND WATER LEAKS

Test windshield, windows, and cab underflooring for leaks by spraying water under pressure against cab, while assistant inside cab marks points of leakage, if any exist.

NOTE: To determine the exact location of leak at flooring or cowl, remove floor mat and dash panel pad. Water which shows up at a certain place inside cab may actually be entering at a point other than where water is found. Back-track path of water to point of entry.

After location of leak has been determined around glass, dry surface and apply rubber cement. Apply cement to outside, both between glass and weatherstrip and between weatherstrip and body.

Apply body sealing compound over all the other leakage points.

If leakage occurs at door opening, check weatherstrip. Replace if necessary. If door does not firmly contact weatherstrip, align door as described in applicable cab section.

CAB ALIGNMENT (STEEL CONSTRUCTED CABS)

Since cab is an integrally welded structure, repair should be attempted only by competent craftsman using proper tools and equipment. For best results, only genuine factory parts should be used for replacement. As work progresses, cross-checking with an adjustable tram bar is recommended for obtaining proper alignment.

STRAIGHTENING (STEEL CONSTRUCTED CABS)

Before attempting repair of a damaged cab, the chassis frame must be checked and aligned as described in FRAME (SEC. 2).

To straighten frame, it may be necessary to remove cab. Never attempt to straighten cab unless cab is firmly attached to chassis. The inner paneling of cab should be straightened first. Use of a push-pull hydraulic jack, together with extension and adapters is recommended for this type of repair.

After straightening framing, it is important that strains set up in framing be relieved or "normalized." Normalizing consists of heating areas of greatest tension with a torch. Holding torch nozzle about 2" from metal, move torch over an area of 3" to 4" until the metal barely begins to turn red. Cooling must be slow to avoid changing characteristics of the metal. Apply slight heat with torch, if necessary, to retard cooling.

DINGING AND FINISHING (STEEL CONSTRUCTED CABS)

Paint is quickly scuffed off sharp dents leaving metal exposed to rusting and corrosion; therefore, importance of proper metal finishing to produce a fairly smooth surface should not be underestimated. Application of hammer directly to panel tends to stretch the metal and cause a great deal of unnecessary work. Whenever possible, a spoon should be used under the hammer when bumping a panel. Repair damaged panels by forcing outward in direction opposite to force which caused damage. In this way metal strains, set up when damage occurred, are relieved.

PAINTING SHEET METAL (STEEL CONSTRUCTED CABS)

REPAINTING

1. Thorough cleaning is essential. All corrosion products, grease, and other foreign matter must be removed. Use of phosphoric base metal conditioners, such as "Metalprep" (Neilson Chemical Co.) or "Dioxidine" (American Chemical Paint Co.) or equivalent is recommended in preparing steel for painting. These materials vary in method of application and use, and should be employed only as directed by the manufacturer. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.

2. Completely remove old paint by use of organic or alkaline solvents. However, if alkaline removers are used, all traces of alkali must be washed off before primer is applied. If old primer is very difficult to remove, and if there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.

3. Apply primer, preferably by spraying, and allow to dry. Use a good oxide primer obtained from a reputable manufacturer.

4. Apply finish coats:

a. For understructure or other parts not requiring color, apply two coats of a good air-drying black or other automotive lacquer.

b. To exposed body parts, apply surfacer and paint in accordance with standard practice.

PAINTING NEW PARTS

New replacement parts should be thoroughly cleaned and painted, as outlined previously under "Repainting," after installation in vehicle. In addition, hidden surfaces of panels should be cleaned and coated with one heavy coat of sheet-metal deadener.

IMPORTANT: Calcium chloride and other salts, road tar, excretion from insects ("tree sap"), chemicals from factory chimneys and other foreign matter may permanently damage the finish of the trucks. Frequent, regular washing and a thorough cleaning after exposure is recommended to prevent damage by these substances.

PAINTING ALUMINUM PORTIONS OF ALUMINUM TILT CAB

Aluminum corrodes just as iron and steel rusts. Under certain conditions aluminum will corrode more rapidly than steel. Inspect body surfaces regularly for corrosion and paint condition.

Only sound parts can be refinished. If rust or corrosion is excessive, replace with new parts. Remove old parts from aluminum cab. Refinish all exposed adjacent parts which remain on vehicle cab. When installing new parts use only zinc or cadmium coated bolts, washers, and nuts.

The instructions which follow cover both steel and aluminum parts and both new and old parts. Zinc coated metals are also covered by these instructions.

PAINTING NEW ALUMINUM PARTS AND REPAINTING OLD PARTS

1. Thorough cleaning is essential; all corrosion, grease, and other foreign matter must be removed. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.

2. Completely remove old paint by use of organic solvents. Do not use alkaline paint remover on aluminum. If old primer is very difficult to remove and there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.

3. Wipe the entire area to be refinished with cloths saturated with DuPont No. T-3812 reducer (or equivalent). Wipe dry.

4. Treat any scratched or abraded areas with DuPont No. VM-5717 metal conditioner (or equivalent) reduced one (1) part by volume with four (4) parts of water.

a. Apply the above mixture with a sponge or brush and allow to stand approximately three (3) minutes.

b. Wipe area with a damp cloth. Dry thoroughly.

5. Apply a coat of pre-primer (sometimes called wash-primer), preferably by spraying to a uniform and complete coverage coat on all surfaces. This type primer uses a special accelerating agent containing phosphoric acid which produces an excellent bond to metal. AP-10 or A-158 made by M & T Chemical Co., XE-5220 made by Bakelite Corporation, and 818-012 (2 parts), plus T8539 (1 part) made by DuPont, or any equivalent material made by a reputable paint manufacturer should be acceptable. These materials must be used within a few hours after addition of accelerator, therefore, directions of manufacturer should be observed carefully. Apply by spraying. Allow parts to dry.

6. Use a zinc chromate primer such as DuPont No. 63-150 or Pontiac Varnish Company's GMT-434, or any equivalent material made by a reputable manufacturer. Apply primer, preferably by spraying, to a minimum thickness of 0.5 mils. Allow parts to dry.

7. Apply finish coats:

a. For understructure and other parts not requiring color, apply a second coat of DuPont No. 63-150 or Pontiac Varnish Company's GMT-434, or equivalent.

b. To exposed body parts, apply desired color coats in accordance with standard practice.

c. Apply DuPont No. 181-65751 aluminum enamel top coat for final refinishing process in those areas where anodized aluminum panels are to be matched.

ALUMINUM CAB FRAME AND PANEL REPAIRS

CAB FRAMING

General Information

Principle cab framing is composed of box-type members of welded aluminum construction. This assures a stress resistant foundation designed to fortify cab against twisting and flexing. Further rigidity is achieved by strategically located reinforcement braces and brackets.

Cab Frame Repairs

Riveted and welded major cab sections and framing should be regularly inspected for damage and repaired immediately. Loose or missing rivets and fractured welds can result in considerable damage to cab structure unless repairs are made promptly.

Since repairs to aluminum components require special skills, cab understructure repairs should only be performed by competent craftsmen with proper tools and equipment.

Whenever repairing or replacing aluminum parts, carefully follow accepted and recommended practices. The Aluminum Company of America will furnish, upon request, booklets titled "Riveting Aluminum" and "Welding and Brazing Aluminum." The booklets explain detailed procedures necessary in repair and replacement of aluminum parts.

Proper precautions must be observed, particularly with reference to welding, reinforcing, corrosion prevention, and replacement, as follows:

1. Welding of major aluminum structural members or any aluminum parts subject to strain or compression without proper reinforcement is not recommended. To maintain proper body strength replace damaged structural members with new parts obtained from the factory.

2. To prevent galvanic corrosion of aluminum, all surfaces of dissimilar metals in contact with aluminum must be properly coated with paint and/or plating. This also applies to attaching parts such as bolts, washers, nuts, and rivets.

3. When cutting a structural member, cut at an angle of 30 degrees. Thus, actual length of cut is twice width of piece being cut, and stress or load is distributed over a longer joint when welded. Cutting can be done bv torch, although use of saw is preferred since less material is removed.

4. Avoid mixing steel and aluminum structures or parts when making repairs. Do not substitute steel for aluminum in structural parts. Greater deflection of aluminum causes steel members to tend to take entire load when used in combination with aluminum parts.

5. Before reinforcing any part of vehicle,

determine cause of failure. Cab panels and framing are integral, therefore driving stresses and strains are transmitted throughout cab. Reinforcing a point of apparent failure without correcting underlying cause of failure may transfer stress to other parts not engineered for such stress, with resultant development of new failures.

6. Reinforcements can be made of flat, angle, or channel stock, whichever is most suitable for the purpose. Use of angle reinforcements is recommended due to difficulty in fitting channel reinforcements. Reinforcements should be sufficiently long to distribute load evenly over a considerable area. Thickness should not exceed that of member being reinforced.

7. Inert arc welding is recommended as heat of weld is localized and burning of material minimized with this method. When welding a cut member, fill or weld cut completely. Welding rods should be of the same material as the parts to be welded.

8. Use of heat when straightening structural parts of body is not recommended since heat will affect structural characteristics of material. Any aluminum part, bent or buckled sufficiently to show strain cracks after straightening, should be replaced or properly reinforced.

CAB PANEL REPLACEMENT

Exterior sheet aluminum panels are riveted to minimize cab drumming and vibration. In the event of sheet metal damage, repairs should be made promptly.

Riveting

Cold aluminum rivets should be used in aluminum parts. Diameter of rivets should be approximately 100% thickness of plates to be riveted although rivet diameter is also dependent upon spacing and number used.

Replacement of body parts will necessitate removal of rivets in many cases. Remove rivets by cutting off rivet head with a sharp chisel. Mark center of rivet with a center punch, then drill out rivet with a drill slightly smaller than body of rivet. Rivet can also be driven out with punch instead of being drilled out, depending upon type and size of material riveted. If rivet is large, first cut a groove across center of rivet head with a cape chisel before cutting off head with a flat chisel.

Patch Repairs

Small area cab punctures may be covered with small patches of sheet aluminum, sealer, and self-tapping screws. Cut patch to amply cover puncture, coat with sealer, and install screws. To avoid stripping threads, do not over-tighten self-tapping screws. If threads strip, use existing holes and use next larger size screws.

Smaller punctures may be repaired with epoxy body filler. Be sure to follow directions of manufacturer.

Sealing

When replacing front, side, rear, and particularly roof panels, give special attention to proper sealing of joints with sealing and caulking compounds.

Painting

Information pertaining to painting old and new aluminum components is covered earlier in this section, under "Painting New Aluminum Parts and Repainting Old Parts."

WINDSHIELD GLASS REPLACEMENT

CAUTION

ALWAYS WEAR HEAVY GLOVES TO PREVENT POSSIBLE INJURY WHEN HANDLING GLASS.

NOTE: When replacing a cracked windshield, resulting from causes other than from flying objects, it is very important that the cause of breakage be determined and the condition corrected.

If cracks in glass extend to outer edge of glass, mark cab with chalk at these points so that weatherstrip flange in cab opening can be examined later for possible distortion.

REMOVAL

NOTE: Windshield glass is retained in cab opening with insert-type rubber seal as illustrated in figure 1. A single windshield glass is used in the conventional 7500 series truck whereas two glass sections are used on all other models.

1. Pry end of insert out of rubber seal with a pointed tool; pull insert completely out of seal.

2. With aid of an assistant to hold glass outside cab, push glass forward from inside cab.

INSPECTION

1. Check for the following conditions at the previously marked point of fracture at cab opening:

a. Chipped edges on glass.

b. Irregularities in body opening.

c. Irregularities in rubber channel.

GLASS-TO-OPENING CLEARANCE CHECK (STEEL TILT CAB)

Before installing new glass, check glass opening for proper clearance, using five special spacer blocks (J-9316) as shown in figure 2. With the aid of an assistant, place blocks around perimeter of new glass, two at bottom and top and one at outer

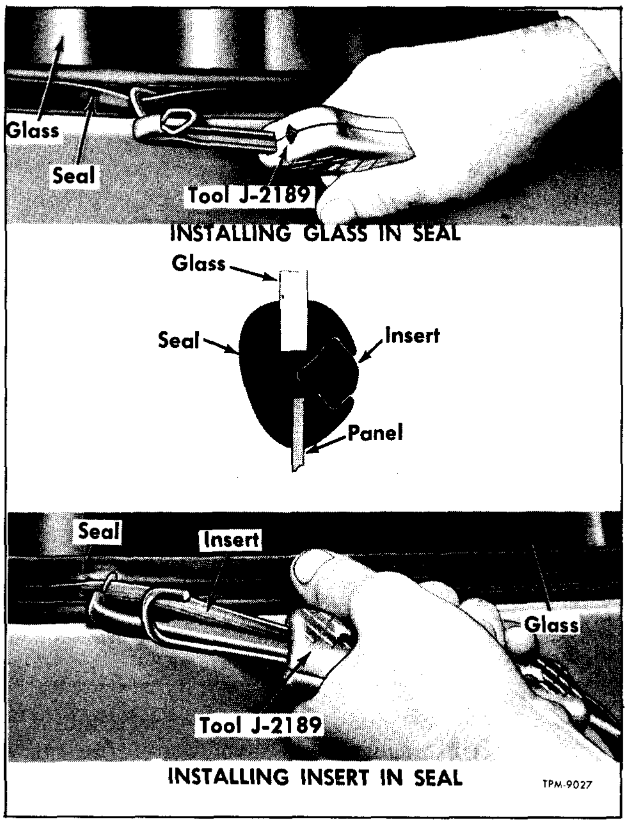


Figure 1—Installing Insert Retained Glass (Typical)

side of opening. A 5/16 to 3/8-inch clearance should exist between the glass and opening flange. Insert blocks into gap, then rotate blocks perpendicular to flange surfaces. If all blocks cannot be installed, rework metal flange or grind off edge of glass at side where block or blocks could not be installed.

If glass clearance is found too small and is to be ground off, place a strip of tape on a line where glass is to be removed. Grind up to edge of tape.

If glass clearance is found too large, braze a continuous piece of 1/8-inch diameter wire to edge

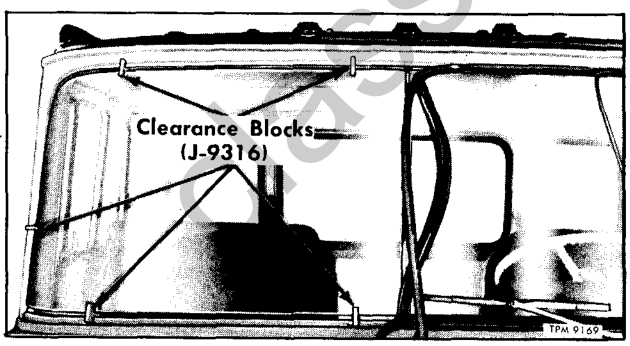


Figure 2—Checking Glass Clearance (Steel Tilt Cab Models)

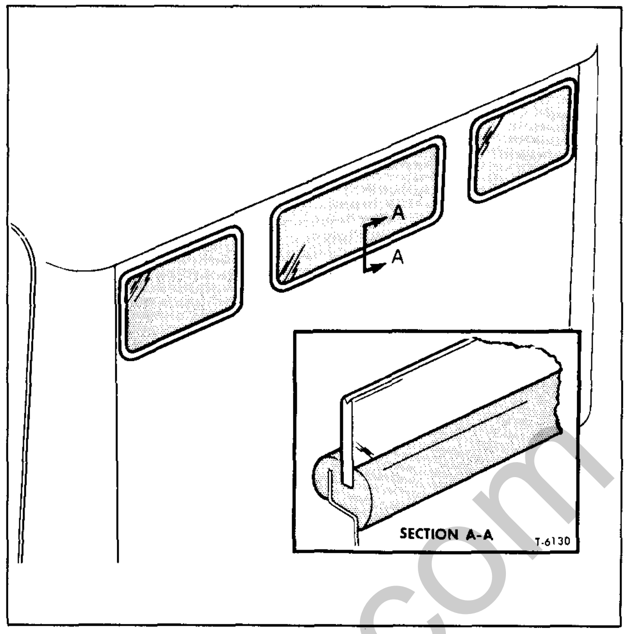


Figure 3—Rear Window Installation (Series 90 Alum. Tilt Cabs)

of cab windshield glass opening flange. This will provide a closer glass and seal fit.

NOTE: Add build-up to flange where necessary. Usually the building up to only one side and one-half way around one corner will provide proper glass and seal fit. Taper off ends of build-up to conform to edge of glass, otherwise glass breakage may occur, originating at a point adjacent to the end of flange build-up.

INSTALLATION

Be sure flange around cab opening is straight to assure a good fit in weatherstrip groove. If desired, sealing cement can be applied between cab flange and weatherstrip.

1. Install weatherstrip on cab opening flange, making sure weatherstrip is pressed in place at corners.

2. With aid of assistant, raise windshield glass to outside of weatherstrip, then hook end of installer tool (J-2189) in glass groove of weatherstrip as shown in figure 1. Move tool around glass to force outer lip of weatherstrip over edge of glass.

3. Slightly moisten insert retainer with diluted liquid soap to facilitate insert installation. Thread end of insert through handle and loop of installer tool (fig. 1). Push tool loop and end of insert into groove of seal. Using a hitching movement of tool to avoid elongating insert, feed rubber insert into tool handle while proceeding around weatherstrip. If a new insert is being used, allow sufficient overlap to assure a tight joint; then butt insert into weatherstrip groove.

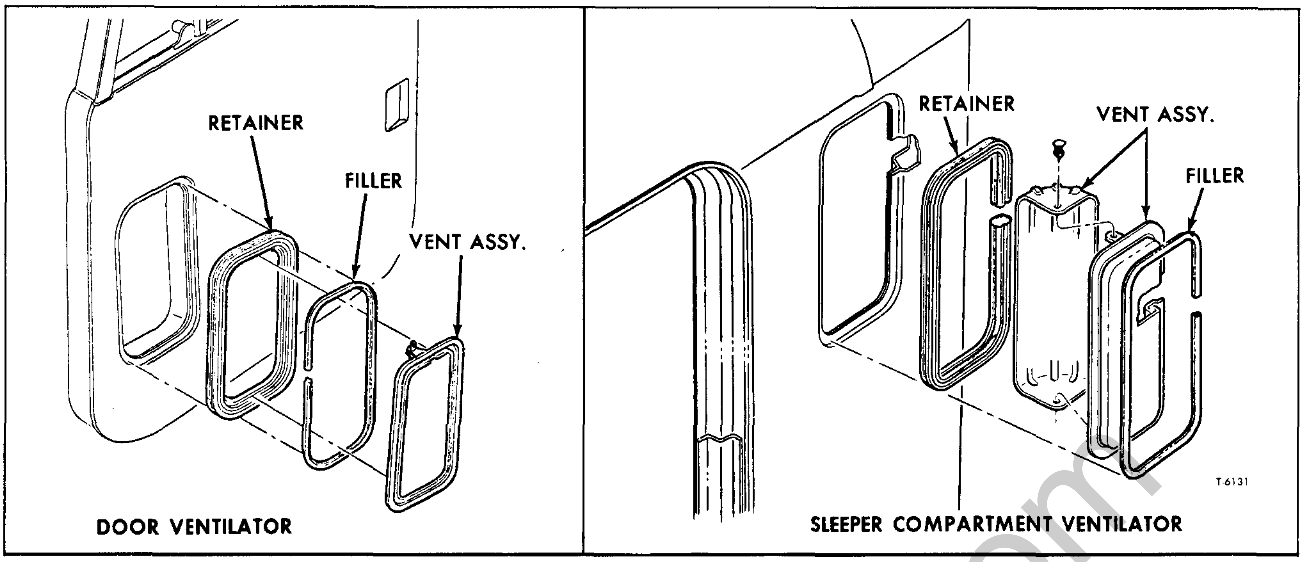


Figure 4—Door and Sleeper Compartment Ventilator (Series 90 Alum. Tilt Cab)

4. Install insert in center vertical weatherstrip in same manner as described in Step 3.

REAR WINDOW GLASS REPLACEMENT (ALL EXCEPT 90 ALUM. TILT CAB)

Rear window glass is retained by means of rubber seal and seal insert (fig. 1). No sealing compound or cement is used.

If body prevents access to rear window, glass can be installed from inside cab by reversing seal so that insert is located inside cab.

1. Pry end of seal insert out of seal with a pointed tool; then remove rubber insert completely. Push glass from inside cab. Pull seal from opening.

2. If necessary, straighten any irregularities of seal flange in cab opening which may have caused breakage of glass.

3. Install new rubber seal over panel flange, pushing it completely into corners. Avoid stretching seal during installation. Cut seal to allow sufficient overlap for a tight joint, then butt ends.

4. Position glass to seal and insert hood end of installer tool (fig. 1) into seal groove. Move tool around glass to force outer lip of seal over glass.

5. Thread end of rubber insert through handle and loop of installer (fig. 1). Push tool loop and end of insert into groove at bottom center of window. Feed in the rubber insert while proceeding around window. Use a hitching movement to avoid elongation of insert.

6. Cut off end of insert, allowing sufficient overlap for a tight joint; then butt into groove.

REAR WINDOW GLASS REPLACEMENT (SERIES 90 ALUM. TILT CAB)

Rear window(s) is retained in cab opening by means of an extruded rubber weatherstrip. No insert retainer is used as is the case for windshield and fresh air ventilators. Secure rear window mounting is assured since weatherstrip is sealed between glass panel and cab opening.

REMOVAL (Fig. 3)

1. Before removing rear window glass, mark weatherstrip with chalk or crayon where cracks extend to outer perimeter of broken glass. Mask or place a suitable covering inside and outside of cab to protect paint finish.

2. To free glass and weatherstrip from cab opening, loosen lip of weatherstrip from pinchweld flange along top and at sides by applying pressure with hand near edge of glass. At the same time, lift lip of rubber weatherstrip over pinchweld flange with a flat bladed tool such as a putty knife.

INSPECTION

Check flange area for solder, weld spots, or hardened sealer - especially at points previously marked. Remove all irregularities and old sealing compound from cab opening.

INSTALLATION (Fig. 3)

1. Place clean rubber weatherstrip around perimeter of glass.

2. Place chalk string in groove of weatherstrip and wrap completely around perimeter twice. Tape ends of chalk string to inside of glass.

3. If necessary, apply a light coating of sealer to edge of entire pinchweld flange.

4. With assistant in cab, lift glass and weatherstrip in position outside of cab opening. Hook lip of weatherstrip over lower pinchweld flange and then push inward on glass while assistant inside cab pulls chalk line from groove of rubber weatherstrip. Weatherstrip lip should be lifted over pinchweld flange as string is pulled. Check entire perimeter of weatherstrip to be sure weatherstrip is over pinchweld flange.

DOOR AND SLEEPER COMPARTMENT VENTILATOR REPLACEMENT (SERIES 90 ALUM. TILT CAB)

PANEL REPLACEMENT (Fig. 4)

The fresh air ventilator in left door, safety glass in right door, and sleeper compartment ventilators are retained in cab opening in same manner as windshield. For replacement of these components, refer to procedure described previously under "Windshield Replacement."

ELECTRIC WINDSHIELD WIPERS AND WASHERS

Two-speed electric type windshield wipers are used on all Series 70 conventional cab models and all steel tilt cab models covered by this manual. Type of wiper used on rear engine models is determined by the body builder.

A single wiper motor, mounted on engine side of cowl, powers both wiper blades on conventional cab models. Two separate motors are used with steel tilt cab models where each wiper motor is bracket mounted to rear side of cowl under dash.

Steel tilt cab models employ separate wiper motor control switches; the left switch incorporates a push-type control for operation of windshield washers.

WIPER ARM ADJUSTMENT

To adjust sweep of blades to provide maximum visibility, turn on wipers, then note sweep of arms.

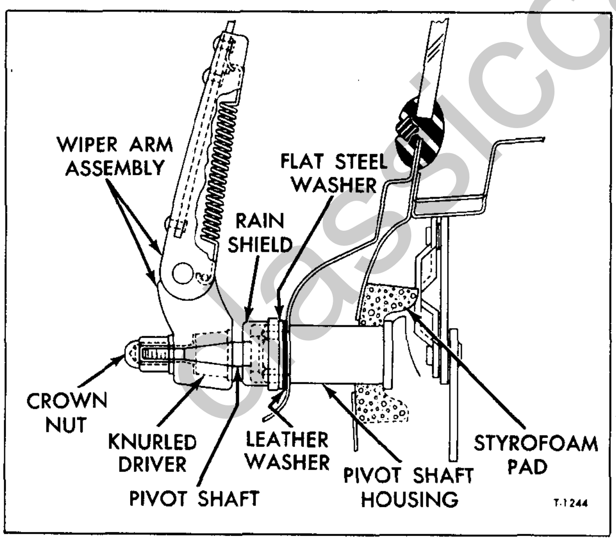


Figure 5—Wiper Arm Installed (Steel Tilt Cab)

CAUTION: DO NOT ATTEMPT TO MANUALLY MOVE WIPER ARMS AS DAMAGE TO LINKAGE OR MOTOR MAY OCCUR.

If necessary, remove arms as follows:

CONVENTIONAL CAB MODELS

1. Pull outer end of arm away from glass which will trip lock spring at base of arm and release spring from undercut of pivot shaft.

2. While holding arm in this position, pull outward on cap section at base of arm to remove the arm.

3. Arm can be reinstalled in any one of several positions due to serrations on pivot shaft and in arm cap.

TILT CAB MODELS

Wiper Arm Adjustment (Fig. 5)

Wiper arm can be repositioned on pivot shaft to provide proper sweep as follows:

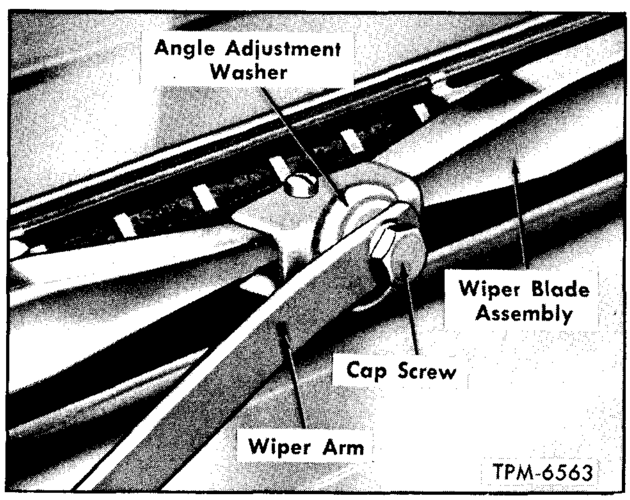


Figure 6—Blade Angle Adjustment (Steel Tilt Cab)

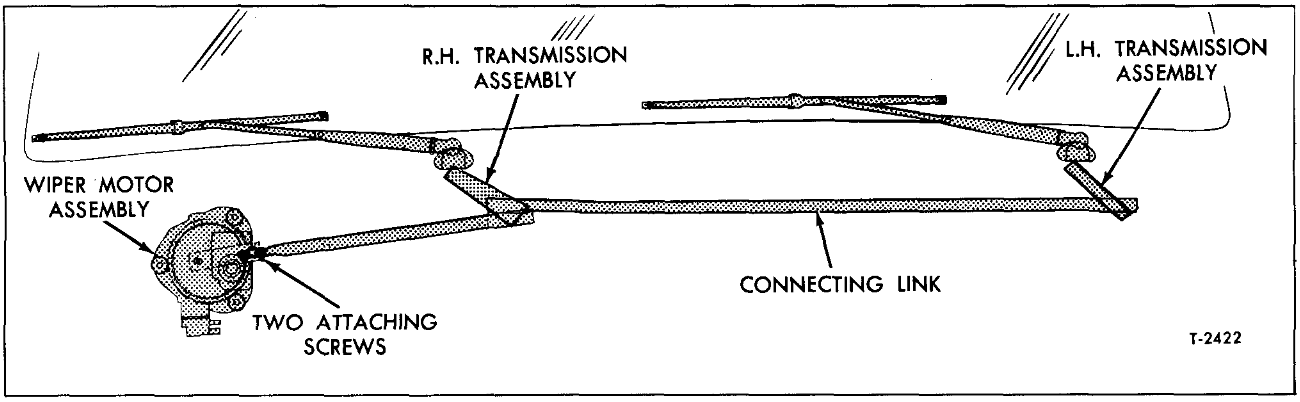


Figure 7—Wiper Motor and Linkage (Series 70 Conventional Cab)

1. Remove hex crown nut and washer which attach wiper arm to knurled driver and pivot shaft.
2. Relocate arm on driver to desired position.
3. Install washer and hex crown nut.

Blade Angle Adjustment (Fig. 6)

To change angle of wiper blade on arm, loosen cap screw which attaches blade to arm. Rotate blade to new position against adjustment washer on arm, then tighten cap screw firmly. When wiper motor is in "PARK" position, blade should be approximately parallel to the horizontal windshield seal.

WIPER ARM TRANSMISSION AND LINKAGE REPLACEMENT (SERIES 70 CONV. CAB MODELS)

REMOVAL (Fig. 7)

NOTE: Both right and left wiper transmission units with connecting link rod and motor link rod are replaced as an assembly.

1. Remove both right and left wiper arms from transmissions. Pull arms outward to disengage arm retaining clip.
2. Remove special retaining nut, steel washer, and seal washer from each transmission at front of windshield.
3. Underneath the dash, remove defroster air outlet tubing if necessary, and any other items to allow access to transmission linkage.
4. At motor crank arm under dash, remove the two nut assemblies which secure link rod to arm. Disengage end of rod from arm.

NOTE: Alternate methods of obtaining access to these two nuts are to move the wiper motor forward from the cowl opening or to remove the ash tray panel.

5. Using a short cross-recess type screwdriver, remove two screws and washer assemblies which attach each transmission unit to underside of cowl. Remove the transmissions with linkage as an assembly.

INSTALLATION (Figs. 7 and 9)

Perform the installation procedures in the reverse of the "Removal" procedures. Make sure the seal washers located below the transmission units at front of windshield are new or in good condition before installing; otherwise leakage may occur later at these two points.

IMPORTANT: Before locating the wiper arms on transmission shafts, make sure wiper motor was stopped in the "PARK" position (fig. 9). Operate motor, then turn switch off and allow it to stop in "PARK" position. If motor is not in "PARK" position and arms are installed, the arm travel may be restricted when motor is started, resulting in a blown fuse. In any case when motor is first started, be prepared to turn wiper switch off in the event wiper arms were installed out of proper sweep position. Reposition arms if necessary.

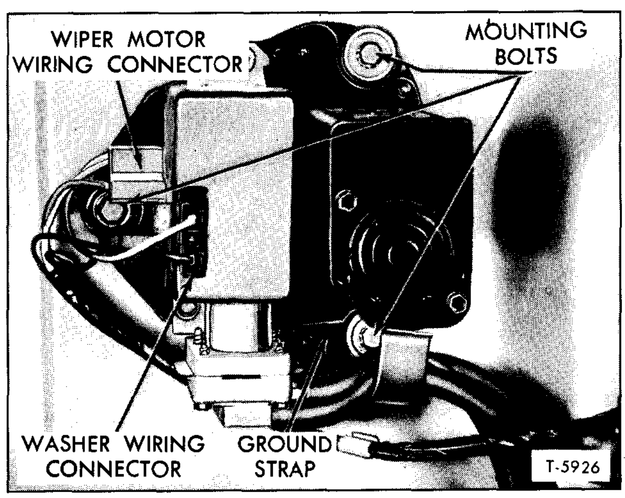


Figure 8—Wiper Motor Installed (Series 70 Conventional Cab)

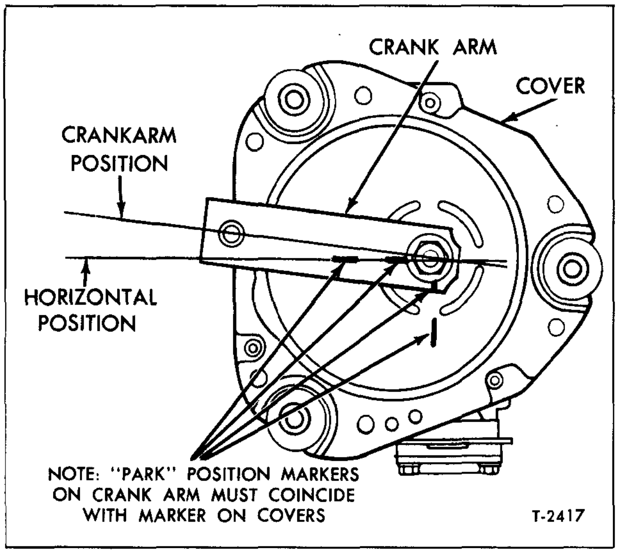


Figure 9—Crank Arm in "Park" Position (Typical)

WIPER MOTOR REPLACEMENT (CONVENTIONAL CAB MODELS)

REMOVAL (Fig. 8)

1. Disconnect wiring harness at motor.
2. If windshield washers are used, disconnect washer lines at pump.
3. Remove three screw assemblies which attach motor assembly to front of cab cowl.
4. Pull motor forward from opening, then through the opening, remove two nuts from arm-to-link rod ball clamp to separate motor from link rod. Remove motor assembly.

INSTALLATION (Figs. 8 and 9)

Before installing motor, scrape any of the old sealing compound from around cowl opening, then apply a bead of new compound around the opening.

Perform the installation procedures in the reverse of "Removal" procedures.

IMPORTANT: Make sure motor ground strap is free of paint before installing motor mounting screws; otherwise motor will not operate. Also, be sure that wiper motor crank arm is in "PARK" position before attaching linkage and wiring harness.

WIPER MOTOR REPLACEMENT (STEEL TILT CAB MODELS)

REMOVAL (Figs. 5 and 10)

1. Remove hex crown nut and lock washer which attaches wiper arm to knurled driver and pivot shaft. Remove arm and driver.
2. Remove rubber rainshield, hex nut, flat steel washer, and leather washer from pivot shaft housing.
3. Inside of cab, disconnect electrical wiring at connector on motot drive unit. If equipped with washers, disconnect hoses.
4. Remove four cap screws which attach motor and drive unit to cab panel.

INSTALLATION (Figs. 5 and 10)

1. Position styrofoam pad on pivot shaft housing, then locate motor and drive unit to cab panel. Attach unit mounting bracket to panel with four cap screws and washers.

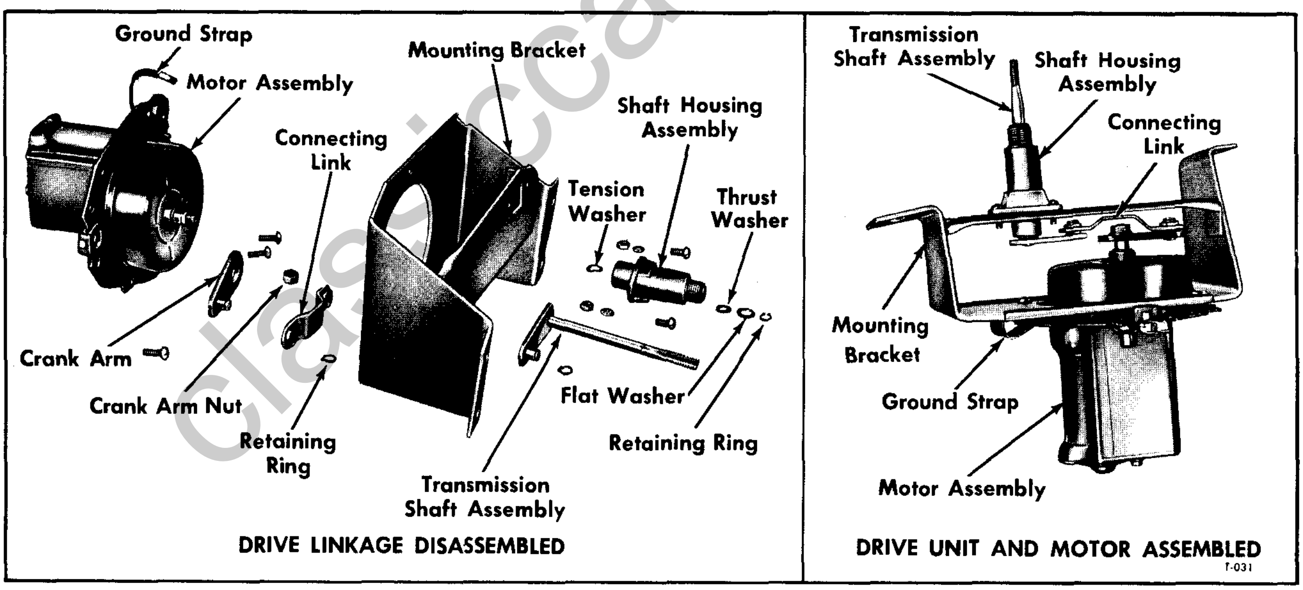


Figure 10—Wiper Motor and Bracket Components (Steel Tilt Cab)

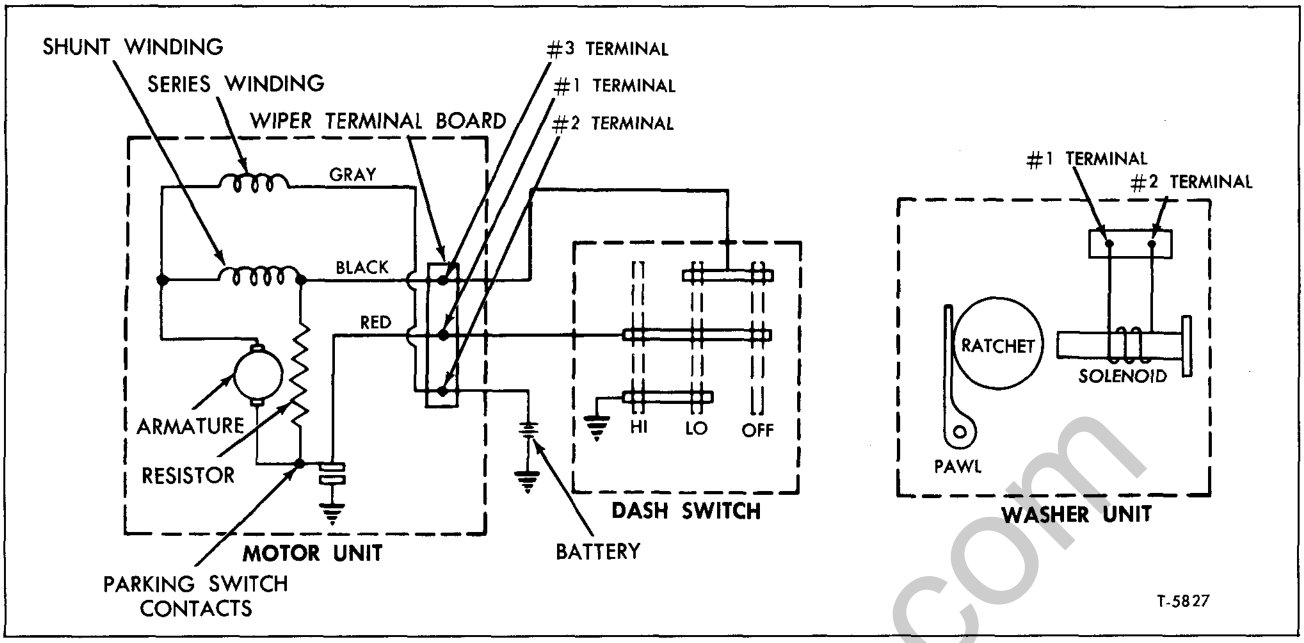


Figure 11—Wiper Motor and Washer Wiring Diagram

IMPORTANT: Be sure a good metal-to-metal contact is made between panel and mounting bracket so as to provide an electrical ground for motor.

2. Connect electrical wiring to terminals on drive unit. If equipped with washers, connect hoses.

3. Install leather washer, flat steel washer, hex nut, and rubber shield on pivot shaft housing. Position arm driver on pivot shaft.

4. Before installing wiper arms, operate wiper motor momentarily, then turn it off which should rotate pivot shaft to "PARK" position (fig. 9).

5. Install arm on driver of shaft so that it is located in the "PARK" position. Wet windshield, then again operate wiper and check arm sweep. Reposition arm on shaft driver if necessary. Secure arm on shaft with crown nut.

WIPER TRANSMISSION LINKAGE AND MOUNTING BRACKET REPLACEMENT (STEEL TILT CAB)

REMOVAL (Fig. 10)

1. Remove small retaining ring near end of transmission shaft, then slide the flat washer and thrust washer from end of shaft.

2. Remove the three small screws which attach motor mounting bracket to motor. Move motor with attached linkage from mounting bracket sufficiently to allow access to connecting link retaining rings.

3. Remove connecting link retaining rings, then remove link. Separate motor from mounting bracket.

4. The transmission shaft can be removed only after the shaft housing is separated from mounting bracket. Housing is attached with two screws, nuts, and washers.

INSTALLATION (Fig. 10)

1. If transmission shaft was separated from housing, locate small tension washer on shaft before inserting shaft into housing.

2. Locate shaft and housing assembly to mounting bracket and attach housing to bracket with two screws, nuts, and washers.

3. Locate motor into mounting bracket, then install connecting link.

IMPORTANT: Make sure end of link marked "Crank End" is connected to motor crank arm. Install link retaining rings.

4. Attach motor to mounting bracket with three screws. Make sure motor ground strap is sandwiched between motor and bracket.

5. At outer end of wiper transmission shaft, install bronze thrust washer, flat steel washer, and the shaft retaining ring.

WIPER OPERATION

DESCRIPTION

The two-speed electric windshield wiper assembly incorporates a non-depressed type (blades park approximately two inches above windshield molding) motor and gear train. The rectangular, 12-volt, compound wound motor is coupled to a train consisting of a helical drive gear at the end of the motor armature shaft, an intermediate gear

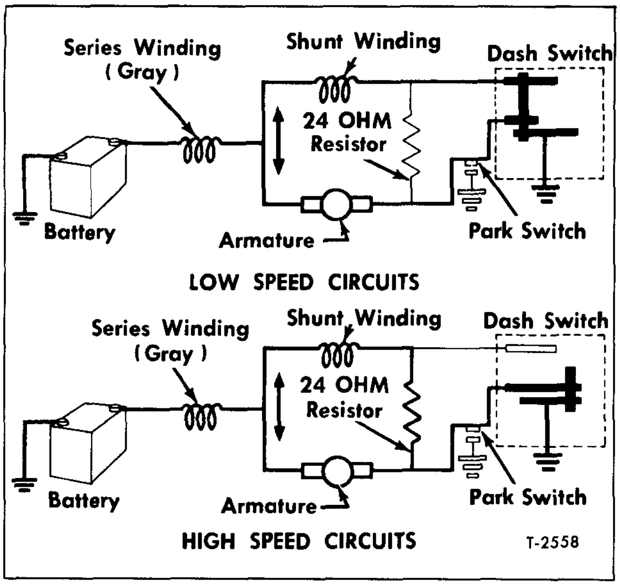


Figure 12—High-Low Speed Circuits

and pinion assembly, and an output gear and shaft assembly. The crank arm is attached to the output gear shaft.

Two switches, a control switch on dash and a parking switch within wiper unit, control the starting and stopping of wiper. Parking switch contacts, located on a terminal board at bottom of drive unit are actually connected across the dash switch and act as a set of holding contacts when the dash switch is turned off. This keeps the wiper circuit closed so wiper can keep operating until the blades reach their predetermined "PARK" position.

When the wipers are turned on, current flows from battery through the circuit breaker or fuse through the motor field and armature to the dash switch and on to ground, starting the wiper.

NOTE: Refer to "Windshield Washer" later in this section for operation of washers.

TWO-SPEED OPERATION (Figs. 11 and 12)

Low Speed Operation

When the dash switch is placed in "LOW" speed position, current from the battery flows through the series field coil and divides; part passing through the shunt field coil to ground at the dash switch, the remaining part passing through the armature to ground at the dash switch.

High Speed Operation

Moving the dash switch to "HIGH" speed position opens the shunt field circuit to ground at dash switch and keeps the armature circuit closed to ground. The shunt field current must then pass through a resistor located on the wiper terminal

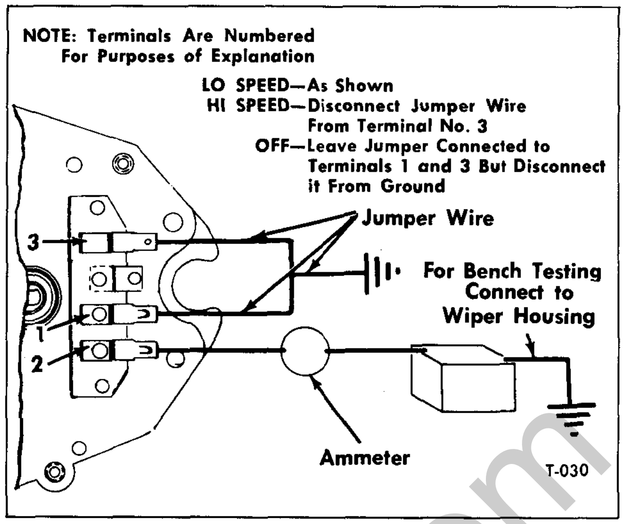


Figure 13—Troubleshooting Wiper Motor Circuit

board, and then through the same lead that connects the armature circuit to ground through the dash switch.

Parking Circuit

When wiper is turned off, circuit is broken at the dash switch. However, current from battery continues to flow through motor, through the parking switch contacts to ground. When wiper blades reach "PARK" position at the inboard end of wiper pattern, the parking switch contacts open, stopping the motor.

TROUBLESHOOTING WIPER MOTOR

Refer to figures 11, 12, and 13 when troubleshooting two-speed wiper.

TYPICAL TROUBLE CONDITIONS

1. Wiper will not shut off.
2. Wiper inoperative.
3. Wiper has one speed (HIGH).
4. Wiper has one speed (LOW) and shuts off with dash switch in "HIGH" position.
5. Blades do not return to "PARK" position when wiper is turned "OFF."
6. Wiper speed normal in "LOW" speed position but too fast in "HIGH" speed position.
7. Wiper operates intermittently.

CHECKING INSTALLED WIPER

Wiper Will Not Shut Off

1. Determine if wiper operates in both "HIGH" and "LOW" speeds. "LOW" speed only, or "HIGH" speed only.

IMPORTANT: Wiper must operate in "LOW" speed during parking cycle.

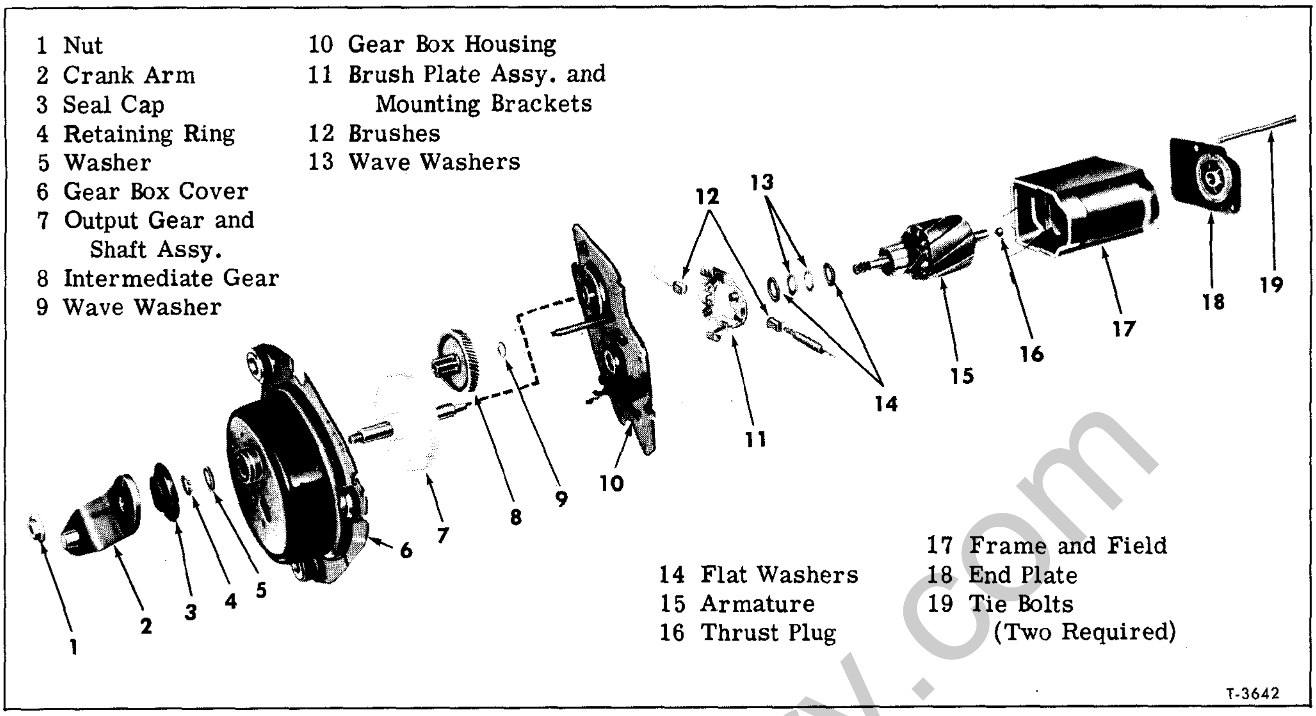


Figure 14—Wiper Motor and Gear Box Assembly (Typical)

2. Disconnect the wiring harness from wiper motor and try operating wiper independently of the dash switch as shown in figure 13. If wiper operates correctly independently of the dash switch (shuts off correctly with crank arm in "PARK" position) refer to possible causes below:

a. If wiper operates in both speeds, lead between wiper terminal No. 1 and dash switch is grounded, or the dash switch is defective.

b. If wiper operates in "LOW" speed only, the lead between wiper terminal No. 3 and dash switch is grounded, or the dash switch is defective.

c. If wiper operates in "HIGH" speed only, the lead between wiper terminal and dash switch is open, or the dash switch is defective.

3. If wiper still fails to operate correctly, remove it from cab, then remove covering from over drive gears and check parking switch contacts which may be broken or stuck in closed position; check for a grounded lead at No. 1 or 3 terminals (fig. 13), or for a grounded shunt field.

Wiper Inoperative

1. Check wiring harness connections at motor and at dash switch.
2. Check fuse (if used) or circuit breaker.
3. See if wiper motor ground strap is secure.
4. Check for loosely mounted dash switch.
5. If wiper still fails to operate, disconnect wiring from motor, and check for 12 volts at motor No. 2 terminal (fig. 13). No voltage indicates defective wiring.
6. With harness disconnected from motor, try operating motor as shown in figure 13. If wiper fails to operate, remove wiper transmission linkage and recheck wiper operation. If wiper operates, linkage is at fault. If wiper does not operate, remove unit from vehicle for disassembly.

Wiper Has On Speed - Fast

Check for a defective dash switch or open lead between motor No. 3 terminal and dash switch.

Wiper Has On Speed (LOW) and Shuts Off With Dash Switch in "HIGH" Speed Position

Reverse harness leads that connect to motor terminals Nos. 1 and 3.

Blades Do Not Return to "PARK" Position When Wiper is Turned Off

1. Check wiper motor ground connection to the cab.
2. Remove wiper motor from cab and check for dirty, bent or broken "PARK" switch contacts.

Wiper Speed Normal in "LOW" But Too Fast in "HIGH"

Remove wiper motor from cab and check for an open motor resistor.

Intermittent Operation

Check for loose wiper ground connection and/or loose dash switch mounting.

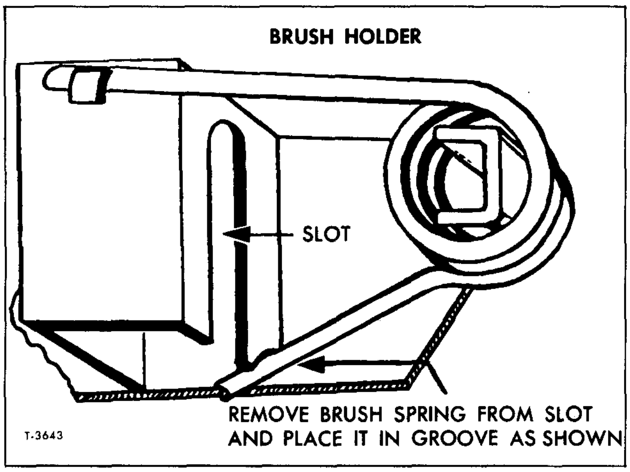


Figure 15—Releasing Brush Spring Tension

WIPER MOTOR AND GEAR BOX DISASSEMBLY AND ASSEMBLY

DISASSEMBLY (Fig. 14)

Gear Box

1. Remove washer pump mounting screws and lift pump from motor.
2. Remove washer pump drive cam (fig. 18). Cam is pressed on shaft but may be removed by carefully wedging two screwdrivers between cam and plate.

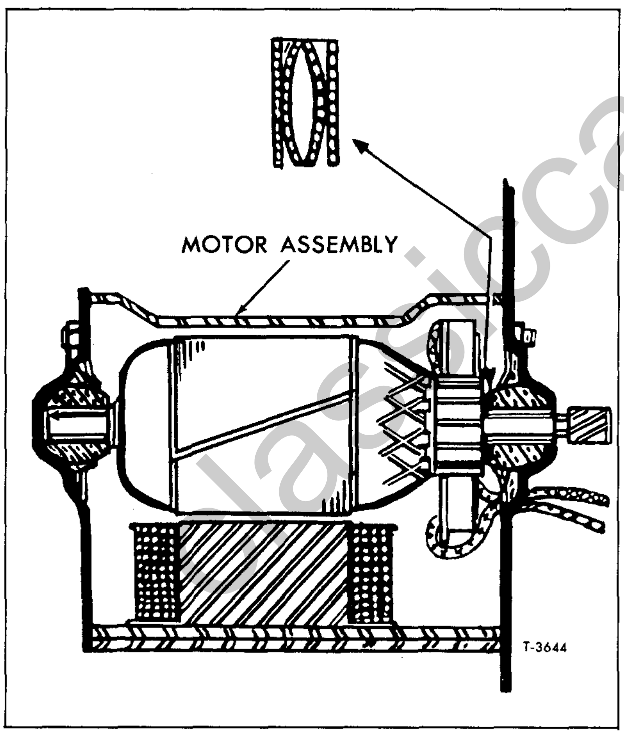


Figure 16—End Play Wave Washer Installation

3. Lightly clamp crank arm in a vise and remove crank arm retaining nut. Separate arm from shaft.

   NOTE: Failure to clamp crank arm may result in stripping of drive gears when retaining nut is removed.
4. Remove seal cap, retaining ring, and endplay washers.
5. Drill out gear box cover attaching rivets and remove cover from motor assembly.

   NOTE: Necessary parts for reassembly of gear box cover to motor is contained in service repair package.
6. Remove output gear and shaft assembly, then slide intermediate gear and pinion assembly off shaft. Note position of wave washers.
7. If necessary, remove terminal board and "PARK" switch by marking wires and unsoldering at terminal lugs. Drill out terminal board attaching rivets and remove board.

Motor

1. Remove motor through bolts, tap motor frame lightly, and separate motor assembly from gear box housing.
2. Remove brush tension by placing brush spring in holder groove as shown in figure 15.
3. Slide armature and end plate from motor frame and field. Note arrangement of wave washers (fig. 16) on gear end of armature shaft before removing to assure proper installation upon motor assembly.
4. Pull end plate from armature. Note thrust plug between tip of armature shaft and end plate.

INSPECTION

Check armature shaft, gears, and supporting bushings for wear. Inspect commutator for evidence of arcing or loose solder joints to armature windings. Check "PARK" contacts for dirt or oxidation. Inspect for worn brushes, weak springs, and binding in holders.

In general, inspect all parts for serviceability and replace as required. All parts can be replaced individually except motor frame and field which is serviced as an assembly. Service kits provide all necessary attaching parts for installation of gear cover and terminal board.

ASSEMBLY (Fig. 14)

Motor

Reassemble motor using reverse order of "Disassembly" procedures.

NOTE: Be sure wave washers on armature shaft are installed properly as shown in figure 16. Lightly lubricate armature shaft bushings with light machine oil. Be sure brushes are properly positioned in holders before armature commutator protrudes between brushes.

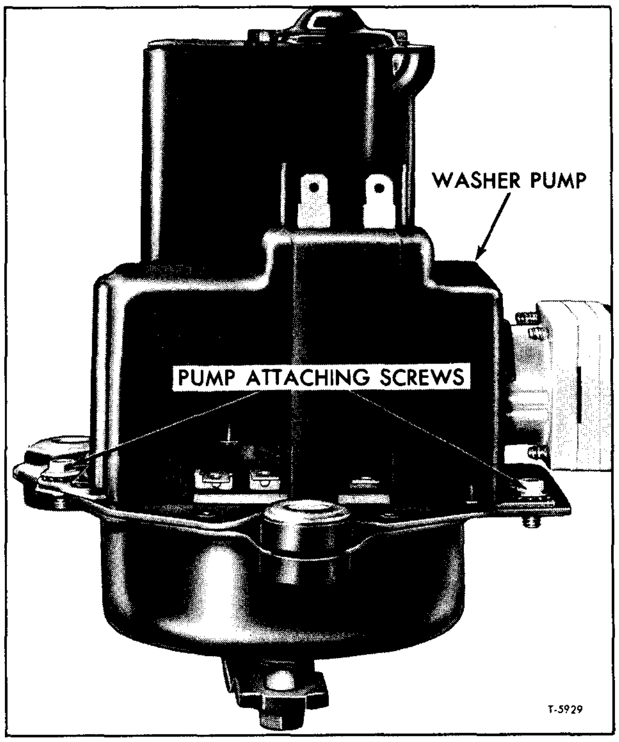


Figure 17—Washer Pump Attaching Screws

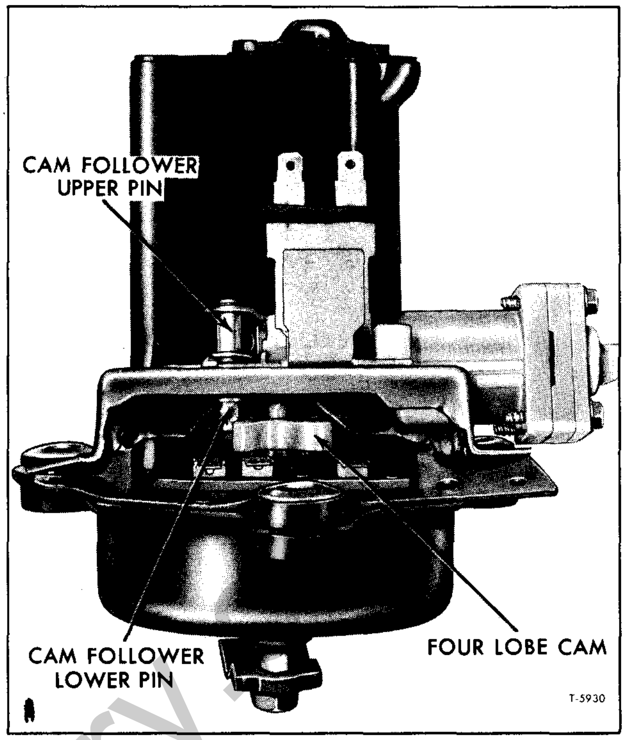


Figure 18—Separating Pump from Motor

Gear Box

1. Assemble gear box in reverse order of "Disassembly" procedures.

NOTE: Lubricate gear teeth with Delco Cam and Ball Bearing Lubricant or equivalent. Be sure cover is located over dowel pins and that ground strap is properly positioned before securing cover.

Seal cap (fig. 14) should be cleaned and re-packed with water-proof grease before reassembly.

2. Install crank arm on output shaft so that alignment marks line up with those on cover when wiper motor is in "PARK" position (fig. 9). Replace and tighten retaining nut after placing crank arm in vise.

3. Check operation by connecting assembled motor to battery as shown in figure 13.

WINDSHIELD WASHER PUMP

GENERAL INFORMATION

The washer pump used on the rectangular non-depressed park wiper motors resembles previous models somewhat in physical appearance but it has been changed considerably internally. Refer to figure 17 for view of pump mounted on wiper motor assembly. Past model pumps used a bellows system for the pumping mechanism whereas the new design incorporates a piston enclosed in a plastic cylinder housing. The piston type pump provides higher pressures and increased volume (fig. 20).

The basic principle of operation is very similar to past model pumps of this type. The pumping mechanism is powered by a four-lobe cam which is pressed on wiper motor output shaft. This cam rotates whenever the wiper motor is running. Programming is accomplished electrically and mechanically through use of a pump solenoid circuit and ratchet wheel arrangement.

OPERATION

Series 70 Conv. Cab (Single Wiper Motor)

Pushing in on the wiper switch knob causes the washer to activate and also causes wipers to activate in "LOW" speed. If operator wishes high speed wiper action he must manually switch to "HIGH" speed. At the end of washer cycle, washer will automatically shut off; wiper must be shut off manually, regardless of high or low speed.

Steel Tilt Cab Models (Two Wiper Motors)

Pushing in switch knob of left-hand wiper switch causes washer to activate, and also causes left-hand wiper to activate in "LOW" speed. If operator wishes "HIGH" speed and/or right-hand wiper action also, he must manually control both. At the end of washer cycle, washer will automatically shut off; wiper(s) must be shut off manually regardless of speed (both left- and right-hand).

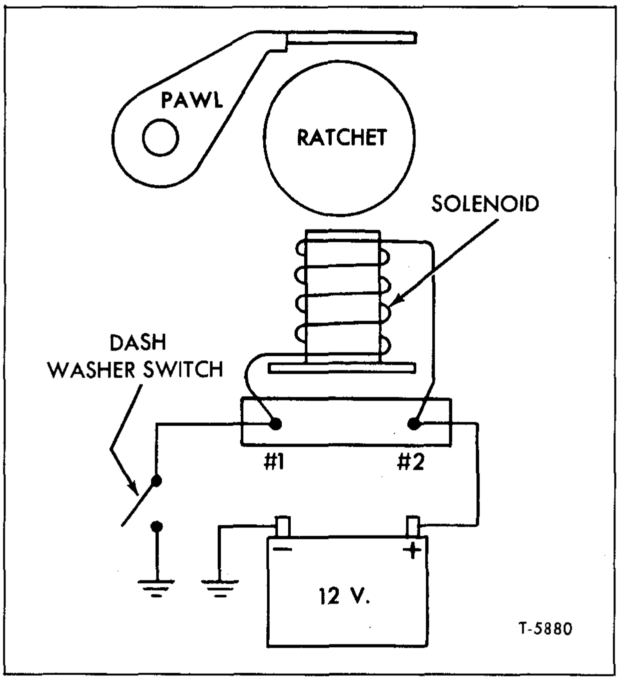


Figure 19—Checking Washer Solenoid

PUMP REMOVAL (Figs. 17 and 18)

1. Disconnect water hoses to washer pump making certain they are properly marked to assure correct installation.
2. Disconnect electric wiring from washer terminals.
3. Remove washer pump attaching screws, then lift pump off wiper motor.

PUMP INSTALLATION (Figs. 17 and 18)

1. Place washer pump in position on wiper motor making sure lever arm pin properly engages four-lobe cam.
2. Secure pump to motor with two mounting screws.
3. Reconnect electric wiring.
4. Reconnect water hoses.

TROUBLESHOOTING WASHER PUMP
(Refer to Fig. 19)

On-Vehicle Check

1. If washer pumps continuously when wiper is on, disconnect wiring from washer pump.
   a. If pump shuts off, trouble is located in wiring harness or dash switch.
   b. If pump fails to shut off in Step a, remove pump assembly from vehicle for further checking.
2. Check the following items if pump is inoperative:
   a. Reservoir contains water solution.
   b. Hoses are not damaged and hose connections are tight.

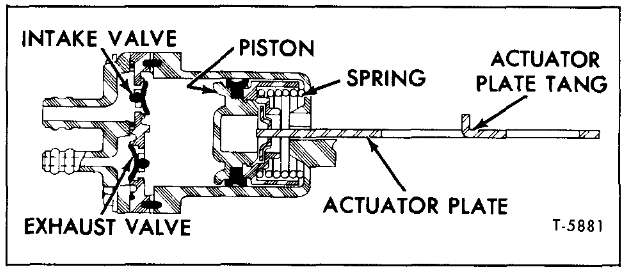
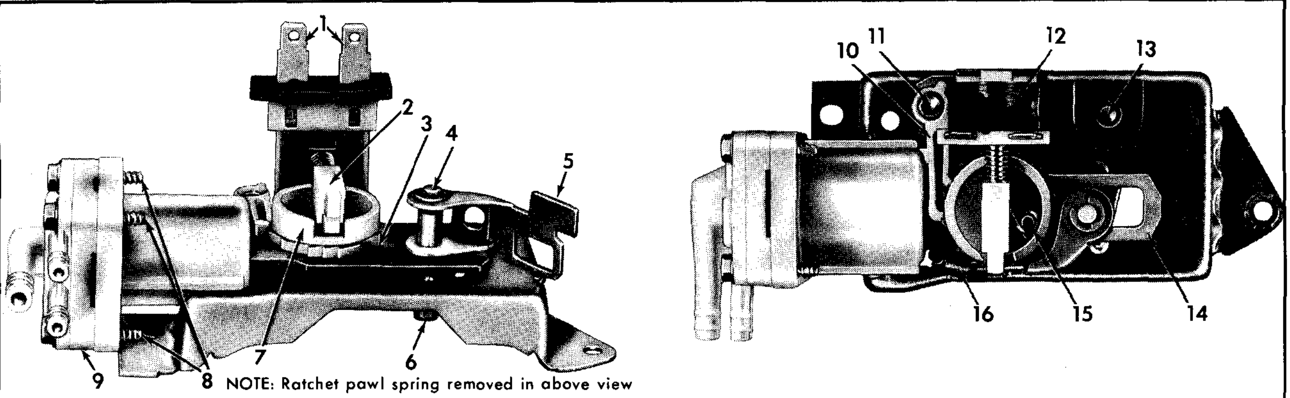


Figure 20—Washer Pump Piston and Valve Assembly

   c. Screen at end of jar cover hose is not plugged
   d. Electrical connections to washer pump and dash switch are secure.
   e. Nozzles are not plugged.
3. If all items in Step 2 check out, start wiper motor only, then push washer button and listen for "click" as washer solenoid pulls in. If no "click" is heard, check for 12 volts at terminal No. 2 (fig. 19). No voltage indicates defective wiring. If "click" is heard, proceed to Step 5.
4. If correct voltage was found in Step No. 3, connect a jumper wire from washer terminal No. 1 to ground (fig. 19) and operate wiper. If washer relay "click" is heard and pump functions correctly, a defective dash switch or an open circuit between washer pump and dash switch is indicated - "No Click" indicates an open pump solenoid.
5. If relay "click" is heard in Step 3, listen for the soft clicking as the pump ratchet wheel is rotated.
   a. If soft clicking is not heard, the pump mechanism is faulty and should be removed from the wiper motor and checked.
   b. If soft clicking is heard but no pumping action occurs, replace the valve assembly and recheck pump.

Bench Check

1. Manually actuate the solenoid plunger and check for binding condition.
2. Check relay coil as follows: Connect 12-volt supply to washer terminals (fig. 19). Observe if solenoid plunger pulls in. Failure of solenoid plunger to pull in indicates an open solenoid coil or poor solder connections.
3. If solenoid plunger pulls in correctly, manually actuate the cam follower lower pin and observe if pump piston and actuator plate operate freely. Locate and correct cause if binding occurs.
4. Attach a hose to the large or intake pipe. You should be able to blow, but not draw, through intake pipe (fig. 20).
5. Attach a hose individually to each of the small exhaust pipes. You should be able to draw, but not blow, through them. If any of the valves allow air to pass in both directions, the valve assembly is defective and must be replaced.



NOTE: Ratchet pawl spring removed in above view

1 Coil Terminals
2 Solenoid Plunger
3 Actuator Plate Tang
4 Cam Follower Upper Pin
5 Ratchet Pawl
6 Cam Follower Lower Pin
7 Ratchet Wheel
8 Valve Assy. Mtg. Screws
9 Valve Assembly
10 Ratchet Dog
11 Dog Retaining Screw
12 Solenoid Coil Assembly
13 Pivot Pin
14 Piston Actuator Plate
15 Ratchet Wheel Spring
16 Ratchet Pawl Spring

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Figure 21—Washer Pump Mechanism

PUMP DISASSEMBLY AND ASSEMBLY
(Refer to Fig. 21)

1. Remove washer pump cover.
2. Remove ratchet dog retaining screw. Hold spring loaded solenoid plunger in position and carefully lift the solenoid assembly and ratchet dog off the frame of the pump.
3. Disconnect ratchet pawl spring. Remove ratchet pawl retaining ring and slide ratchet pawl off cam follower shaft.
4. Move ratchet wheel spring out of shaft groove and slide ratchet wheel off shaft.
5. Pull pump housing away from frame until housing grooves clear frame. Remove actuator plate from ratchet wheel and cam follower shafts.
6. Remove screws that attach valve assembly to pump housing. Separate valve assembly from pump housing.

NOTE: Observe direction of pipes before removing pipe assembly from pump housing.

7. To assemble, reverse "Removal" procedure

NOTE: During reassembly, be sure gasket between housing and valve plate is properly positioned in the housing and valve plate grooves. Also, be sure triple O-ring is properly installed between valve body and pipe assembly. Hose connections on pipe assembly should be pointed in same direction as original position.

AIR-OPERATED WINDSHIELD WIPERS (SERIES 90 CONVENTIONAL CAB)

Dual air-operated motors are used on all Series 90 conventional cab models. Figure 22 illustrates dual wiper motors with their respective linkage. The left wiper motor is equipped with a speed control device (fig. 23) which can be adjusted to balance the wiper speed of motors.

The system air pressure is supplied through a protection valve which is mounted at the brake system foot application valve. This valve automatically shuts off the air pressure to wiper system in the event brake system pressure drops below 60 to 70 psi. Maintenance information on valve is covered in "AIR BRAKES" (SEC. 5B) of this manual.

Periodic servicing is not required other than making sure that all mounting parts are tight and that air lines and line connections are leak-proof.

If inspection indicates a faulty wiper motor unit, the unit can be readily removed from vehicle, disassembled and repaired. For repair information see "Wiper Motor Repair" later in this section.

SERVICING

MOTOR BALANCING SPEED ADJUSTMENT
(Refer to Fig. 23)

The speed of either the right or left wiper motor can be regulated by adjusting the balancing valve which is located at the left wiper motor. While making adjustment, vehicle's air pressure should be 85-100 psi. Make adjustment as follows:

1. Wet the windshield, then start wipers in motion.

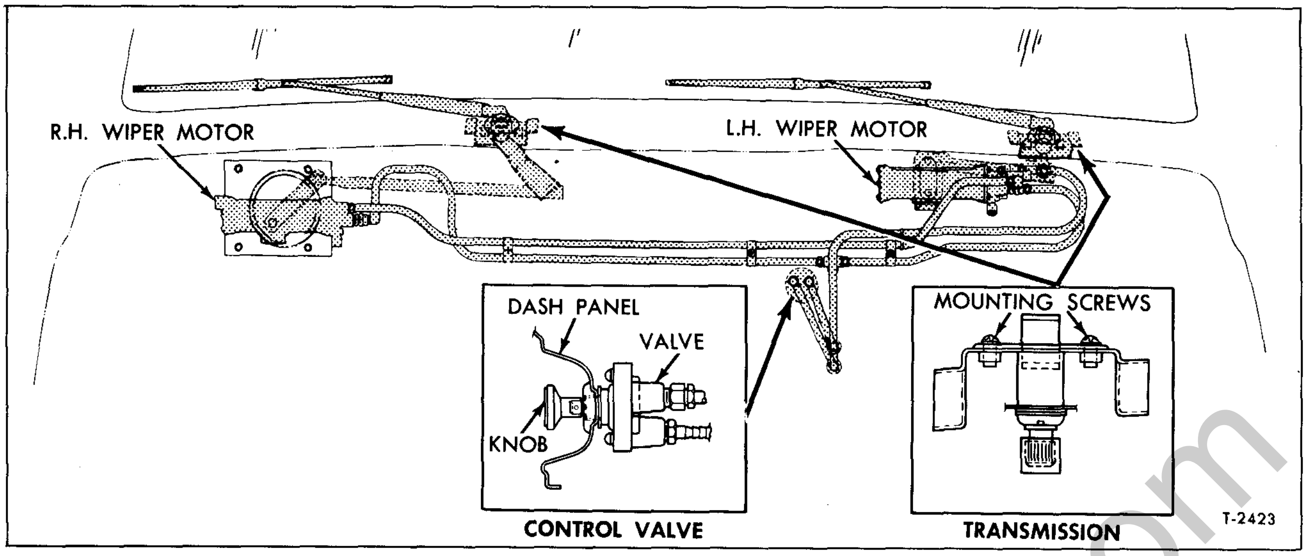


Figure 22—Air-Operated Wipers (Series 90 Conventional Cab)

2. At left-wiper motor, front of cowl, loosen the lock nut at adjusting screw, then turn screw inward or outward to balance wiper speed. Both motors should operate at approximately the same speed. Tighten lock nut after making adjustment.

WIPER MOTOR REPLACEMENT

Removal

1. Disconnect lines at motor.
2. Remove the four motor mounting plate-to-cowl bolts and nuts.
3. Move motor forward from cowl, then through cowl opening, disconnect transmission link from motor crank arm. The link attached to the standard single-type motor and the right motor of optional dual motor system is retained with two small nut assemblies. The left motor is connected to link with a spring clip and flat washer. Remove wiper motor.

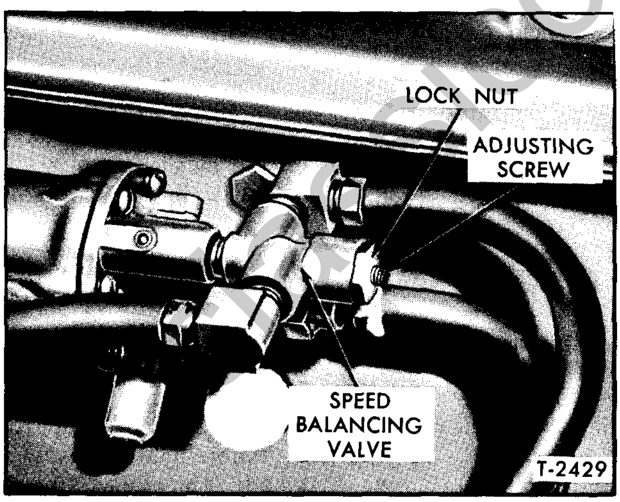


Figure 23—Speed Balancing Valve (Series 90 Conventional Cab)

Installation

NOTE: Before installing motor, remove any old sealing compound from around motor mounting surfaces, then apply bead of new compound to surfaces. Install motor in the reverse sequence of the "Removal" procedure.

TRANSMISSION AND LINKAGE REPLACEMENT

NOTE: Access to transmissions and linkage can be obtained from under dash panel at left side and by removing ash tray panel at the right side. The linkage connection at the motor crank arms is accessible after moving the motor outward from cowl, then reaching through the cowl opening.

1. Remove the wiper arm from transmission shaft, then remove the special retaining nut, steel washer and seal washer from transmission at front of cowl.

2. Remove the two cross-recess screws which attach transmission unit to cowl bracket. Separate the wiper motor from cowl for access to linkage connection at motor crank or separate connection from rear side of cowl. Remove transmission and link. If desired the link can be separated from transmission shaft arm.

3. In the event motor was removed, make sure new sealing compound is applied to motor mounting base before installing. Also, use a new seal washer or one in good condition under the special retaining nut at the transmission shaft, forward of cowl.

TROUBLESHOOTING AND REPAIR

WIPER MOTOR TROUBLESHOOTING

A general inspection of wiper system should precede any attempt to repair motor. Be sure to check air line for plugged fittings, kinked tubing or leaks. Make sure that all connections are tight.

NOTE: A quick method to check for leaks is to disconnect the line, stop up one end and blow smoke through the other; this will reveal the point of leakage, if any.

If air line is satisfactory, turn on wiper regulating valve to diagnose motor trouble as follows:

CONDITION	PROBABLE CAUSE
a. Wiper works slowly or uneven.	Shaft bind. Make sure that shaft is free and does not bind in the hole.
b. Wiper runs slowly and without power.	Packing leaks. Defective valve.
c. Wiper runs with jerks.	Bent valve stop unit.
d. Wiper works only in one direction.	Broken valve stop unit. Valves are bent or sticky.
e. Wiper will not run.	Air line plugged. Valve defective or broken. Gear sector broken.
	Wiper valve or piston gummed up due to foreign deposits, due to dirty air line.

MOTOR REPAIR

Key numbers in text refer to figure 24.

For all internal repairs it is necessary to remove head assembly Views A and C, figure 24. If necessary to take motor apart, all parts should be carefully checked for wear and lubricated before assembly. Worn parts should be replaced.

Valve Head Replacement

1. Remove six valve head attaching screws and turn shaft so that gear rack assembly, View B, figure 24, is brought back as near as possible to the head.
2. Lift head and unhook valve stop unit assembly, View B.
3. To replace head, move gear rack assembly View B, figure 24, as near to the opening as possible.
4. Raise valve stop unit and hook under pin View C, figure 24, making sure that air passage in head is directly opposite air tube in cylinder.
5. Move rack assembly slightly away from end to provide clearance for assembling head.

NOTE: Use new gasket when replacing head.

6. Place a small amount of grease on all moving parts and head. Replace head by reversing preceding removal procedures.

Piston Packings Replacement

1. Remove head as outlined previously.
2. Remove top cover, View A, figure 24, by removing four attaching screws.

IMPORTANT: Be sure cover position is marked so that it can be repositioned exactly when assembling.

3. Remove plate and bushing, then remove shaft and gear.
4. Gear rack can now be withdrawn from cylinder.
5. Dismantle assembly, replacing damaged or worn packings or other parts.
6. Clean all parts thoroughly, lubricating packings and cylinder wall with a special formula grease designed for this purpose.
7. Assemble parts making sure they are placed in their relative positions as shown in View B, figure 24.

IMPORTANT: A shim must be used to slip the gear rack assembly into the cylinder as follows:

a. Wrap entire rack in steel shim as shown in View D, figure 24.

b. Insert rack and shim into cylinder far enough to pass opposite end of opening (View D, fig. 24). Hold shim and push rack down as far as it will go. Hold rack at this point with screwdriver and withdraw shim.

c. Lubricate end of cylinder before replacing head.

Shaft Replacement

1. Remove valve head assembly as described previously.

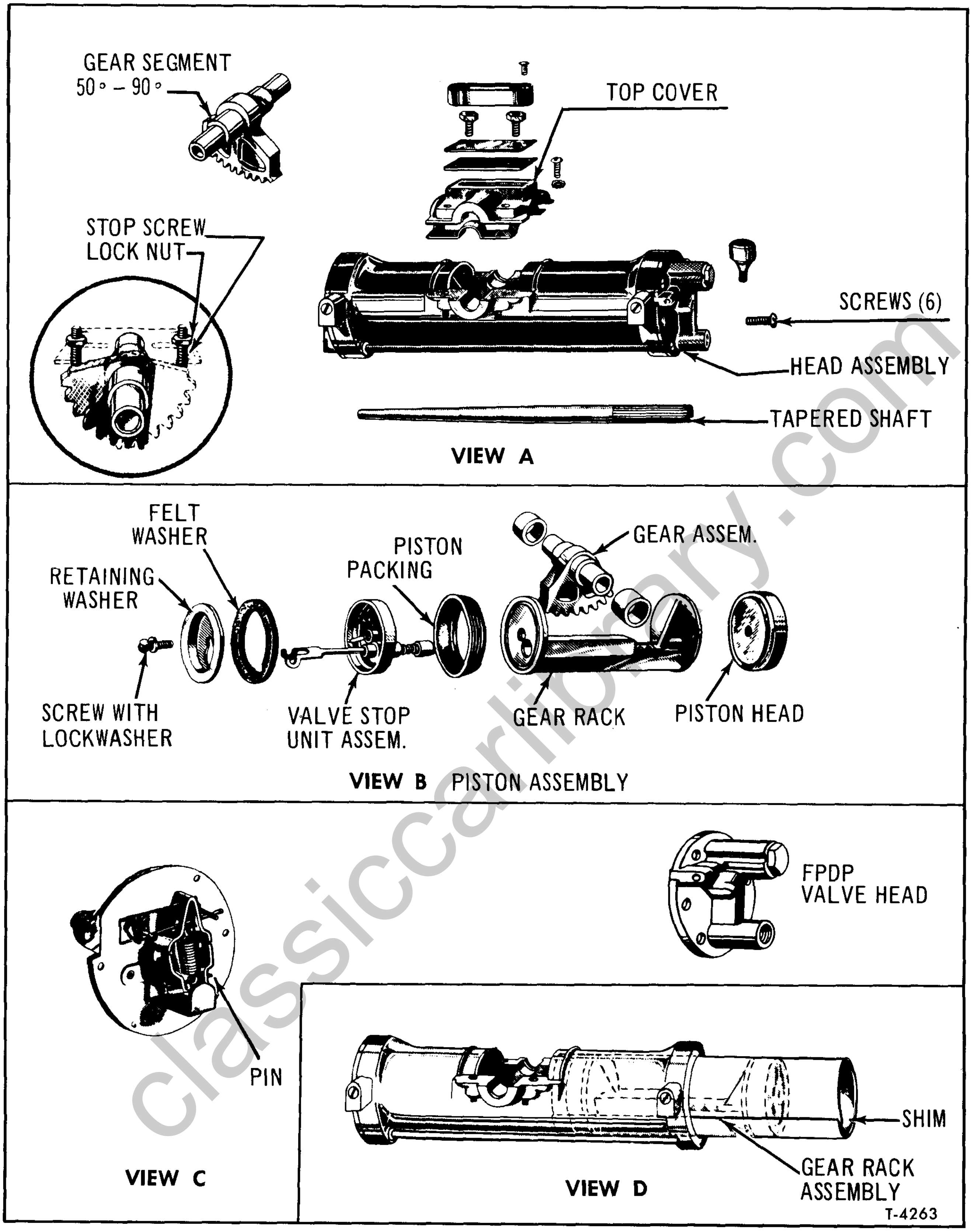


Figure 24—Air-Operated Wiper Motor (Series 90 Conventional Cab)

2. Follow Steps 1 through 3 under "Piston Packings Replacement" mentioned previously.

3. Move rack to center of cylinder and place a little grease in the teeth of the gear rack.

4. Install shaft and gear assembly (View A), making sure that the teeth match in the rack. (The last tooth in sector should mesh with the last tooth of rack at either end.)

5. Assemble top cover, making sure it is in the same position as when removed. Tighten screws securely.

Valve Stop Unit Assembly Replacement

1. Remove valve head assembly as outlined previously.
2. Move gear rack assembly as close to opening as possible.
3. Remove screw from end of piston assembly View B.
4. Replace valve stop unit assembly and tighten screw securely.

Broken Gear Segment Replacement

Remove top plate, shaft, and gear assembly as outlined under "Piston Packings Replacement" and replace as outlined previously under "Shaft Replacement."

Stop Screws' Adjustment

IMPORTANT: The following instructions must be carefully followed, otherwise screws will be improperly set:

1. Turn wiper on and allow to operate at slowest possible speed.
2. Remove top cap by prying up with screwdriver, forcing out rivets.
3. Loosen lock nut, View A, figure 24, and run down stop screw, View A, figure 24, until wiper is stopped by screw.
4. Back out screw just enough to permit wiper to operate. With stop screw in this position, run down and tighten lock nut.
5. Repeat the previous operations on the remaining stop screw.

AIR-OPERATED WINDSHIELD WIPERS (SERIES 90 ALUM. TILT CAB)

GENERAL INFORMATION

Two air-operated piston-type motors (fig. 25) are mounted inside cab beneath dash panel and are readily accessible for service. Both motors receive air pressure through a single air control valve (fig. 30) that is located on center console below heater control panel.

Windshield wipers are designed to require no special maintenance and should remain undisturbed unless motors fail to function. Before removing motors, check control valve, tubing, and connections for plugging or leakage. Make sure that adequate air pressure is delivered to motors.

WIPER ARM ADJUSTMENT (Fig. 26)

Operation of windshield wipers can be observed without wetting windshield glass by inserting a 1¼" x 1/16" cotter pin or nail into hole at base of each wiper arm, adjacent to hinge area, after pulling arms forward slightly. This will prevent blades from contacting dry windshield when wipers are operated.

To adjust wiper blades to provide maximum visibility, turn on wipers and observe sweep of arms. Park wipers and measure perpendicular distance from horizontal windshield weatherstrip to outer tip of wiper blade. Dimension should measure four inches. If arm adjustment is required, proceed as follows:

1. While holding arm to prevent damage to linkage, remove crown nut (and washer if used) which retains wiper arm to serrated pivot shaft.
2. Using a hex-wrench, loosen bolt which clamps arm head to pivot shaft.
3. With wiper motor in "PARK" position, remove and reposition wiper arm on pivot shaft so that dimension from outer tip of wiper blade to horizontal windshield weatherstrip is four inches.
4. Install crown nut (and flat washer) on pivot shaft. Hold wiper arm and tighten crown nut to 20-25 foot-pounds torque.
5. Tighten hex-head clamp bolt firmly.
6. Operate wipers on wetted windshield and observe blade sweep. Park blades and recheck dimension from tip of blade to weatherstrip insert.

IMPORTANT: DO NOT attempt to manually move parked wiper arms as damage to linkage or motor may occur.

WIPER MOTOR AND LINKAGE REPLACEMENT

MOTOR REPLACEMENT (Fig. 25)

1. Exhaust pressure from air supply system and then disconnect air supply lines at wiper motor inlet ports.
2. Disconnect retainer clip attaching motor driver arm to wiper pivot assembly link.
3. Remove four attaching bolts securing motor bracket to front body inner panel. Remove motor and bracket assembly from under dash.
4. Reverse removal procedure to install.

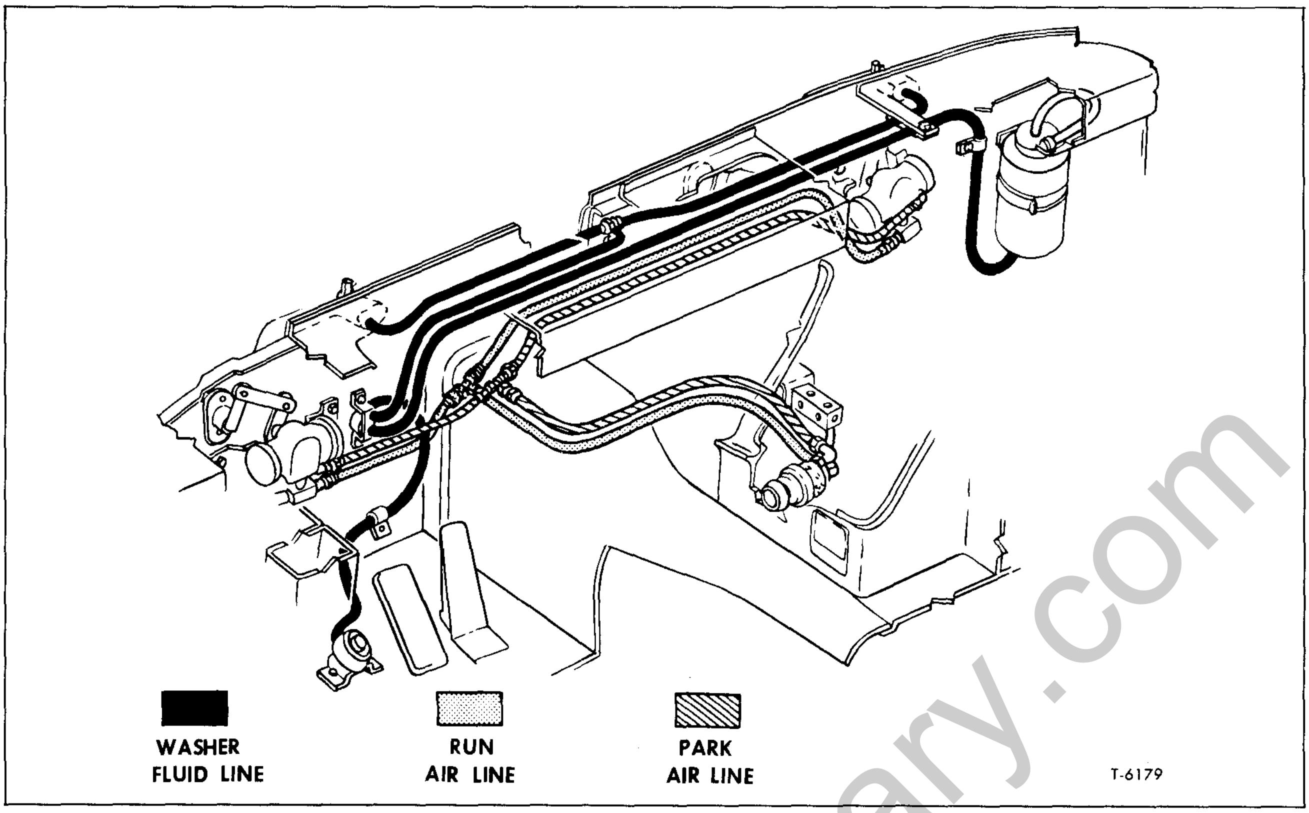


Figure 25—Air-Operated Wiper and Washer Lines (Typical)

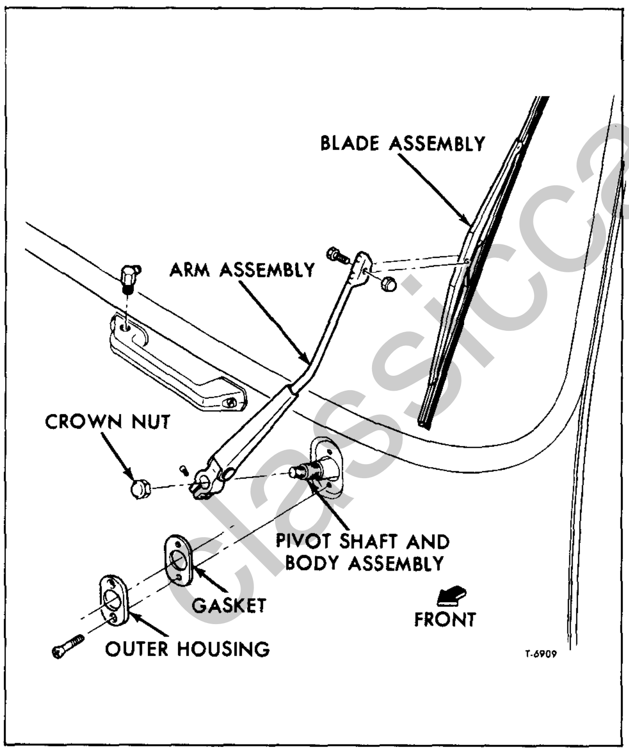


Figure 26—Wiper Arm Installation

LINKAGE REPLACEMENT (Fig. 26)

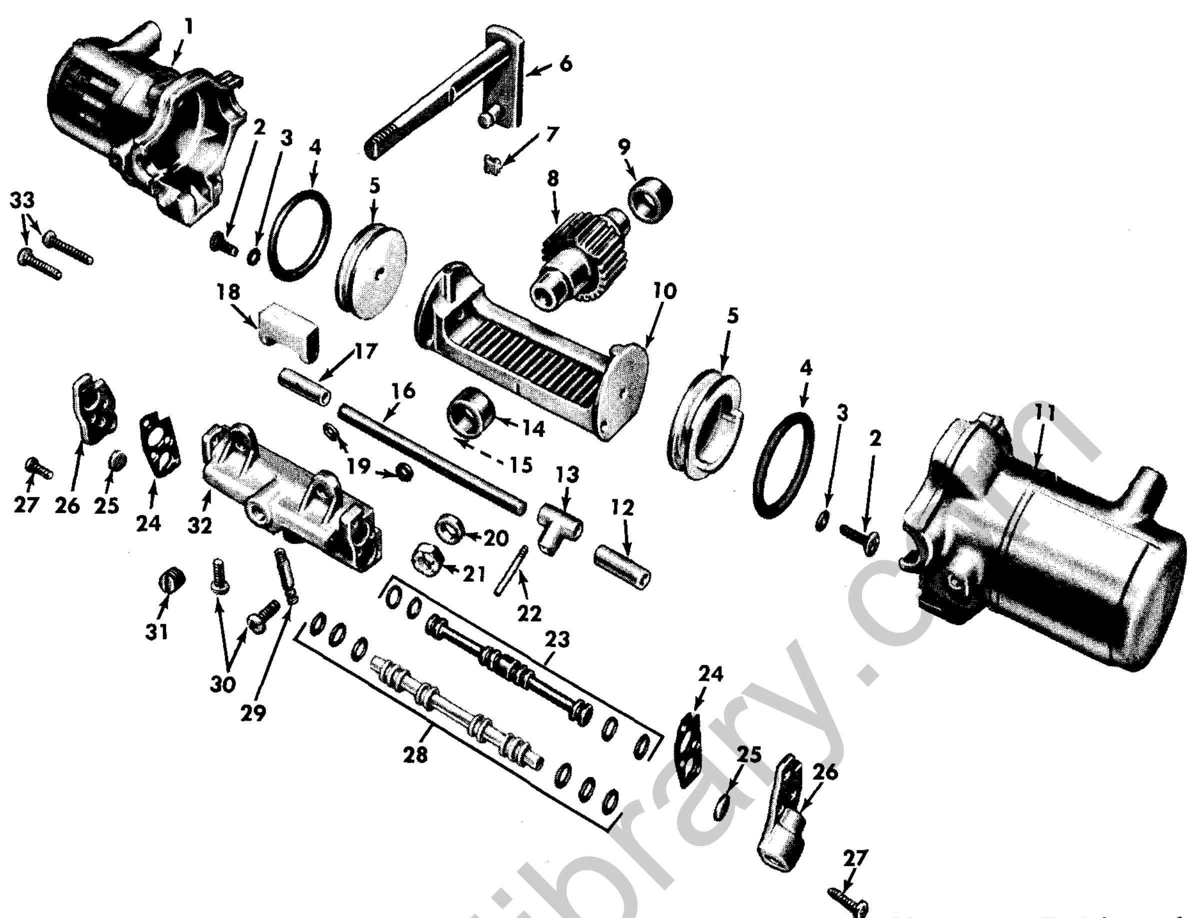
1. Remove air motor and bracket assembly as described previously.
2. Remove wiper arm from serrated pivot shaft as described previously.
3. From front of cab, remove two cross-recessed screws that attach pivot housing to cab body. Remove outer pivot housing cover from cab.
4. From inside cab, remove pivot housing from beneath dash.
5. Reverse removal procedure to install. Be sure to apply a small amount of high temperature zinc-oxide lubricant to pivot shafts and linkage connections. Also apply sealing compound between front face of pivot and inner body panel before installing. Firmly tighten two screws that attach outer pivot housing to front of cab.

WIPER MOTOR OVERHAUL

A repair kit for windshield wiper motor (fig. 27) is available through an authorized Chevrolet Warehouse. Repair kit includes all parts necessary to properly service air motor.

SEPARATION OF MAJOR SUB-ASSEMBLIES

1. Remove retainer which attaches link to motor shaft assembly.



1 L.H. Body
2 Screw
3 Washer
4 O-ring
5 O-ring Adapter
6 Transmission Shaft
7 Retaining Clip
8 Transmission Gear
9 Front Bearing
10 Piston Rack
11 R.H. Body
12 Reverser Stop
13 Reverser Tee
14 Rear Bearing
15 Shim (When Req'd. - not shown)
16 Reverser Rod
17 Reverser Stop
18 Thrust Block
19 O-ring
20 Spacer
21 Nut
22 Valve Pin
23 Primary Rod Assembly
24 Gasket
25 Disc
26 End Plate
27 Screw
28 Secondary Rod Assembly
29 Adapter
30 Screw
31 Plug
32 Valve Body
33 Piston Body Screws

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Fig. 27—Windshield Wiper Motor Components (Series 90 Alum. Tilt Cab)

2. Remove nut and spacer which attach motor transmiswion shaft into wiper motor. Pull shaft assembly from motor assembly.

3. Remove four bolts which attach mounting bracket assembly to motor. Remove bracket.

4. Remove four screws which attach wiper control valve body to motor piston body assemblies. Remove valve body and body O-rings. Figure 28 shows body separated.

5. Place right half of piston body (half with threaded screw holes) in vise so that attaching screws are up.

IMPORTANT: Tighten vise only enough to hold body.

6. Remove screws which retain piston bodies.

7. Slowly lift off upper piston body.

8. Note position of alignment marks on gear and piston rack (fig. 29). Mark on gear is on rear side of gear tooth. Mark on rack is cast in rack at center line. Remove gear assembly, noting locations of thick and thin bearings.

9. Remove thrust block.

10. Note position of valve reverser tee in body slot, and remove the piston assembly.

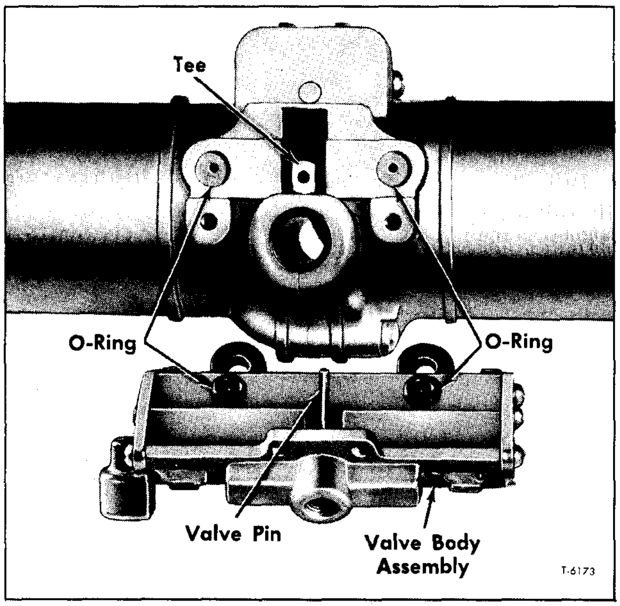


Figure 28—Wiper Motor Valve Body Removed

BUILD-UP OF MAJOR SUB-ASSEMBLIES

1. Apply clean wiper motor grease to all moving or sliding parts.
2. With right piston body assembly placed in vise, install piston assembly into piston body.
3. Install thrust block. Make sure pin notch is properly positioned to align with body attaching screw later.
4. Assemble bearings with shim washers (if needed) on gear and sleeve assembly. Use shim washers with bearings when endplay exceeds 0.010".

NOTE: Install gear and bearings into body. Make sure alignment marks on gear and rack are aligned (fig. 29).

5. Install left piston body assembly over piston assembly. Attach the bodies together with screws. Tighten screws firmly.
6. Referring to figure 28, place O-rings on bosses of valve body as shown. Carefully place valve body to motor piston bodies, then install valve body attaching screws. Tighten screws firmly.
7. Attach mounting bracket to motor with four bolts and lock washers.
8. Install motor transmission shaft assembly to motor, making sure shaft link is positioned to align with upper wiper arm shaft lever. Install spacer and nut.
9. Install shaft lever link in transmission shaft and secure with retaining clip.

WIPER MOTOR VALVE DISASSEMBLY AND ASSEMBLY

1. Remove screws, then remove parking end plates and gaskets from valve body. Remove discs from end plates.

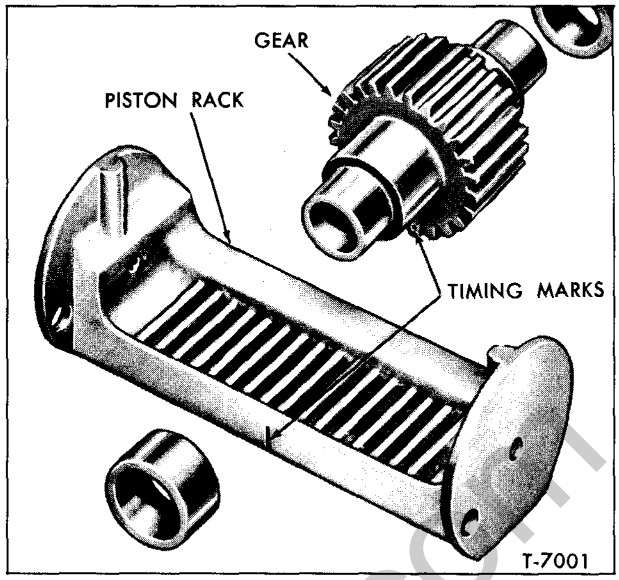


Figure 29—Gear-to-Piston Rack Timing Marks

2. Unscrew valve pin projecting from valve body side.
3. Push out primary rod and secondary rod from valve body.
4. Remove rubber O-rings from rods.
5. Clean the valve body, end plates, mounting screws and rods with solvent and wipe rubber O-rings with clean cloth. Examine all parts for wear and defects. Replace all worn and defective parts.
6. Apply wiper motor grease to valve rods and rubber O-rings.
7. Install rubber O-rings on rods, then push rods into valve body.

NOTE: Make sure tapped hole in primary rod is in position to align with valve pin.

8. Thread valve pin into primary rod.
9. Make sure rubber discs are installed in end plates. Install end plates to valve body.

WIPER MOTOR PISTON DISASSEMBLY AND ASSEMBLY

1. Remove the rubber O-rings from O-ring adapters.
2. Remove screw at each end of piston assembly, then lift off O-ring adapters.
3. Note assembled position of reverser tee and reverser stops, then disassemble components.
4. Clean all parts thoroughly, then examine for wear and abrasion. Replace parts if required. Grease rubber O-rings and gear rack liberally.
5. Referring to figure 27, assemble tee, and reverser stops on reverser rod as shown. Position reverser rod on piston rack, then locate right and left O-ring adapters to piston rack and secure with screws. Tighten screws firmly. Install O-rings on adapters.

WIPER MOTOR AIR CONTROL VALVE

Wiper motor air control valve can be removed from console for cleaning or repair as necessary. Repair parts are available through an authorized Chevrolet Warehouse.

REMOVAL

1. Exhaust pressure from air supply system.

2. Disconnect battery or disengage master circuit breaker on console control panel. A white ring around base of button is visible when master circuit breaker button is pulled out. This must be done to prevent danger of shorting electrical circuits as air control valve is removed.

3. Remove access panel over console.

4. Remove knob, attaching nut, and washer from control valve shaft.

5. Inside console, observe position of air lines to control valve. Identify each line with different colored tape to assure correct installation to valve later. Remove air lines from valve and then carefully remove valve from beneath console.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 30.

1. Scribe a mark from control body (1) to control cover (9) to assure correct position to each other upon reassembly.

2. Remove six screws (10) which attach control cover (9) to control body (1). Cover to body should separate due to compressed internal spring (5).

3. Separate body O-ring (2), slide valve (3), slide valve plate (4), and spring (5).

4. Pull shaft and lever assembly (6) from control cover (9). Remove O-ring (8) and retainer clip (7) from shaft and lever assembly (6).

INSPECTION AND ASSEMBLY

Clean all parts in alcohol and dry with compressed air. Inspect all parts for damage, especially for deterioration of rubber components, and replace as required. If body, cover, or shaft appears bent or misaligned, entire valve assembly should be replaced.

To assemble, follow reverse order of removal procedure. Be sure to apply wiper motor lubricant to all moving parts, especially valve surfaces and rubber O-rings.

INSTALLATION

Install assembled valve into console and connect flexible air line to valve body. Refer to procedure later in this section for procedure of installing air lines. Build up system air pressure and check operation of wipers.

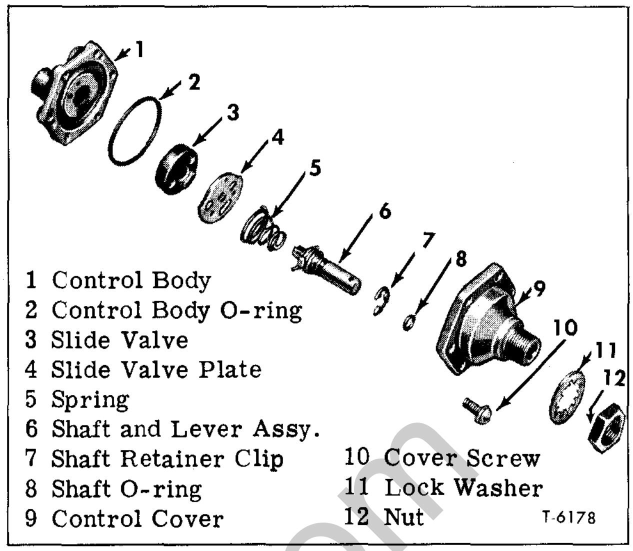


Figure 30—Wiper Air Control Valve Components

WIPER MOTOR AIR LINES

No specific service is required for wiper motor air lines (fig. 25) other than brief inspections to assure air line connections are leak-free and flexible lines are not kinked or punctured.

If any trouble symptoms, such as slow wiper operation, indicates a restricted or clogged air line, disconnect the suspected tube at both ends and blow through it to make sure the passage is clear. Inspect tubing for partial restriction such as would be caused by kinks.

To check for air leaks, coat tubing connections with soap suds. No leakage is permissible. Leakage is sometimes corrected by tightening the connection. If this fails to correct leakage, new fittings or flexible hose must be installed.

To install new flexible lines to connections or junctions, insert flexible tube into fitting until it bottoms on shoulder inside fitting body. Tighten tube nut until ferrule grips tube so that it does not rotate or pull out easily. Continue to tighten tube nut one full turn.

NOTE: Service information pertaining to air lines from air junction fitting to main air supply is covered in "AIR BRAKES" (SEC. 5B) of this manual.

FOOT-OPERATED WINDSHIELD WASHERS

On Series 90 conventional cab and Series 90 tilt cab a foot-operated windshield washer pump is used. On conventional cab models the washer pump is operated by applying foot directly to washer pump located on the cab forward panel at the left of the steering column. On tilt cab models the washer pump is operated by stepping down on the pump bulb located on cab floor in front of steering column. The amount of force applied to either type of washer will determine the height of fluid projection on glass.

To alter the direction of liquid flow to either windshield, perform the following:

Conventional Cab Models - Insert a small round metal instrument into nozzle, then gently move the nozzle tip to new position.

Tilt Cab Models - Use the proper size wrench on hexagonal housing for horizontal directional adjustment. If vertical adjustment is necessary, insert a screwdriver in slot provided in nozzle, then gently move nozzle tip to desired position.

The washer fluid supply reservoir is mounted inside of cab near left kick panel on conventional cab models. On tilt cab models the washer reservoir is mounted inside the cab under the dash, in front of passenger's seat. The reservoir must be removed from its bracket and taken from under dash in order to add fluid.

IMPORTANT: Keep reservoir full and add correct amount of washer solvent to prevent freezing. Operate washer pump several strokes to be sure solvent is in lines. Use GM OPTIKLEEN as directed.

MAINTENANCE

If washers fail to operate properly, check spray nozzles, reservoir fluid strainer, lines, washer valve and foot pump for restrictions. Washer components should be flushed with water. If necessary, replace foot pump or washer valve if either becomes inoperative.

LAP BELT MAINTENANCE

Keep belts clean and dry. Clean periodically with a mild soap solution and lukewarm water. Keep sharp edges and damaging objects away from belts. Periodically inspect belts, buckles, retractors, and anchors for damage that could materially lessen the effectiveness of the belt installation and repair or replace the questionable parts. Do not bleach or dye belts as this may cause severe loss of strength.

If necessary, to replace belts or related attaching parts be sure to tighten lap belt anchor bolts to 55-65 foot-pounds torque.

NOTE The lap belt fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified above to assure proper retention of this part.

CONVENTIONAL MODEL CAB

Contents of this section are listed in index below:

NOTE: Maintenance information on painting, windshield glass, and windshield wipers which is common to all types of cabs is explained at beginning of this group in "GENERAL MAINTENANCE" section.

Information on sheet metal components is covered in SHEET METAL AND FIBERGLASS (SEC. 11) in this manual.

CAB DESCRIPTION

The basic conventional cab is of all steel welded construction (fig. 1). Cab side construction consists of a one-piece body door opening frame which assures more positive sealing around the door when closed.

The one-piece roof panel has longitudinal ribbing to stiffen and reinforce the roof.

The floor panel, also of one-piece construction eliminates joints, pockets and seams which normally act as moisture traps.

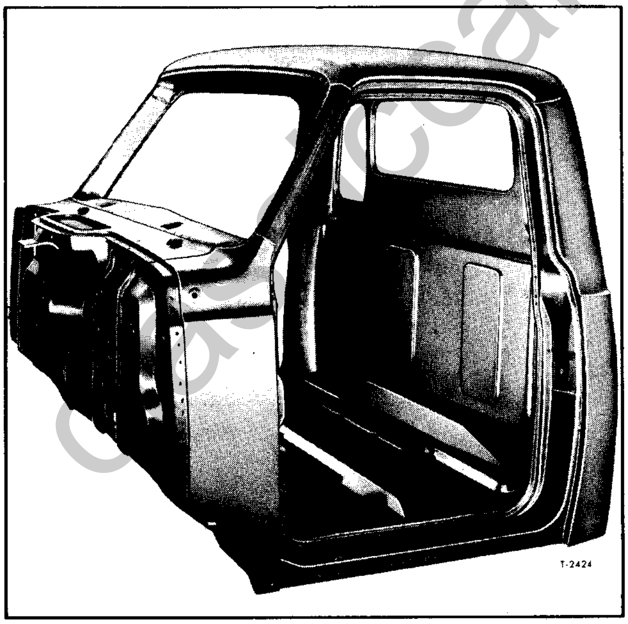


Figure 1—Cab Welded Construction

In most cases, all paneling pieces are lap-jointed and welded for maximum in sealing and structural strength.

Doors are of double-wall construction. Lower inner panel of door has a cut-out allowing access to door control mechanism for adjustment and parts replacement. Horizontal slots in door hinge assembly provides for adjustment of door in cab opening.

Door vent window is of friction-type with positive theft-resistant latch.

The windshield used on all conventional cab models covered in this manual is of the one-piece type.

Front outside air intake is located at top cen-

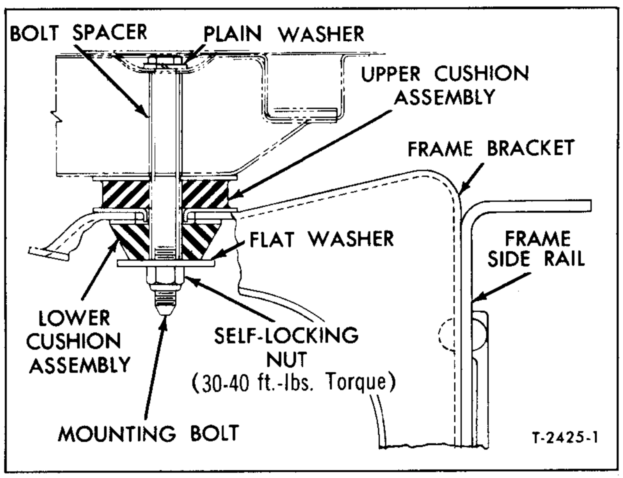


Figure 2—Cab Front Mounting

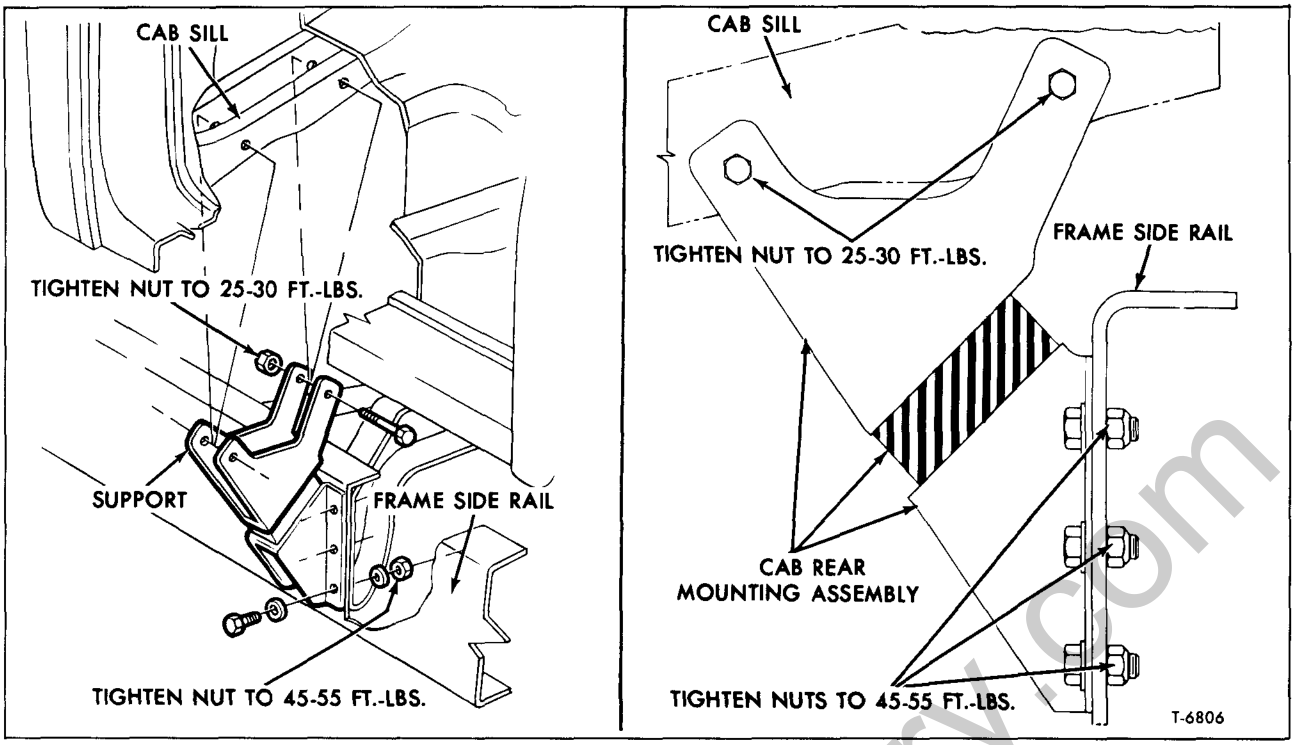


Figure 3—Cab Rear Mountings

ter of cowl. Opening and closing of intake is controlled by push-pull lever at top of dash panel.

Outside air for the heating system enters through a separate louvered opening at right side of cowl.

CAB MOUNTINGS

Four point type cab mountings are used on these vehicles.

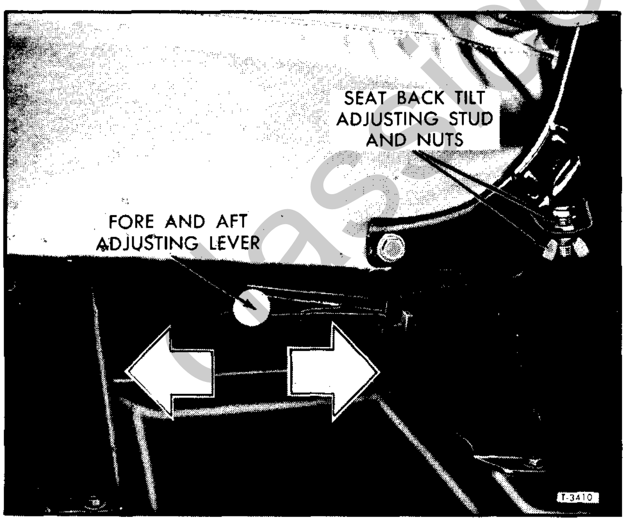


Figure 4—Full-Width Seat Back Adjustment

The front mount consists of an upper and lower cushion assembly as shown in figure 2.

Cab rear mounts are of the semi-shear type and are serviced only as an assembly. The semi-shear type rear mounts are bolted to the cab sill and the frame side rail as shown in figure 3.

At regular intervals, all cab mountings should be checked for loose attaching parts and for deteriorated or collapsed rubber cushions.

Any one cab mounting can be readily replaced after removing the weight of cab at that particular mounting.

IMPORTANT

Raise cab only to height necessary to replace mounting components. If cab is raised too high, damage to vehicle operating controls, wiring and lines may occur.

SEATS

CLEANING SEATS AND UPHOLSTERY

Care of the soft trim material is a relatively simple but important matter. Accumulation of dirt and grime on the surface eventually turns into a hard, gritty substance which actually cuts into the surface of the material.

Vinyl Coated Cloth

To clean the seats, use lukewarm, not hot or cold water, and any mild soap, such as castile. Work up thin suds on a piece of cheesecloth and rub upholstery briskly. Remove suds with a damp cheesecloth, using no soap, and finish by rubbing with a dry cloth. Do not use furniture polishes, oils, varnishes or ammonia.

Woven Nylon Fabric

Soap and water, regardless of the basic type of soap, is not recommended for cleaning nylon fabrics of the type used on these vehicles.

1. Carefully brush all loose particles of dirt and soil.

2. Immerse small cloth in volatile type cleaning solution, wring out thoroughly, open cloth and allow medium evaporation.

Do not use too much cleaning fluid; some interior trim assemblies are padded with rubber, and volatile cleaners are generally solvents for rubber. The application of too much cleaner may destroy these rubber pads or cause the rubber itself to penetrate the upholstery fabric and soil it.

3. Place cloth on soiled spot, do not rub, apply slight tapping pressure, several times. This will pick up particles which are too embedded to be removed in the brushing operation. This operation should be repeated several times - in each instance using a clean area of cloth.

4. Immerse a new cloth in cleaner, wring out thoroughly, open and allow to evaporate until barely damp. Apply increased pressure and rub soiled area in a backward and forward motion. The cleaning cloth should be reversed several times in this operation.

5. Immerse third cloth, wring out, allow evaporation and apply to both the soiled and the area surrounding same, using a light, brisk motion.

6. Repeat brushing operation.

7. If a cleaning ring should form, the entire area of the assembly which is being cleaned should be thoroughly brushed and gone over lightly with the solvent.

SEAT ADJUSTMENT
(FULL-WIDTH TYPE)

If right-hand and left-hand seat adjusters do not release simultaneously, lengthen or shorten adjuster lock rod underneath the seat assembly.

A stud adjustment nut and wing nut at ends of seat-back frame (fig. 4) provide a means of changing tilt of seat-back. To change tilt of seat-back, loosen each wing nut and turn adjustment nuts above seat-back frame brackets an equal amount to raise or lower seat-back. Tighten wing nuts to secure desired position.

SEAT TRACK REPLACEMENT

NOTE: The seat track assemblies are more readily replaced after seat assembly is removed from cab.

1. Remove four screws which attach each track assembly to seat cushion. Lift seat assembly from cab.

2. If only one track assembly is to be removed, disconnect lock rod between tracks, then remove four bolts which attach each track to cab floor panel. Remove track assembly.

3. Reverse the above procedure to install track assembly.

DOORS

DOOR REPLACEMENT

Component sub-assemblies of cab doors, such as window regulator, door lock, remote control, and vent window can be replaced without necessity of removing door from cab. Doors can be replaced without prior removal of above components.

Replacement of door glass is explained later in this section.

Instructions for replacing door assembly are as follows:

REMOVAL (Refer to Fig. 5)

1. Using small punch, drive spring pin up from door check strap at cab bracket.

2. With aid of an assistant to support weight of door, remove three cap screws which attach each hinge strap to door. Remove door and hinge shims (if used).

INSTALLATION (Refer to Fig. 5)

1. Position door to hinge straps and install attaching cap screws loosely. Insert shims (if used) between hinge and door. Note direction of slots in upper and lower hinge shims in illustration.

2. Adjust door-to-cab opening as explained later under "Door Adjustments."

3. Connect door check strap to cab pillar bracket by driving spring pin down from the top.

NOTE: It is not recommended that the access panel be removed from door inner panel for the purpose of storing heavy tools in door compartment.

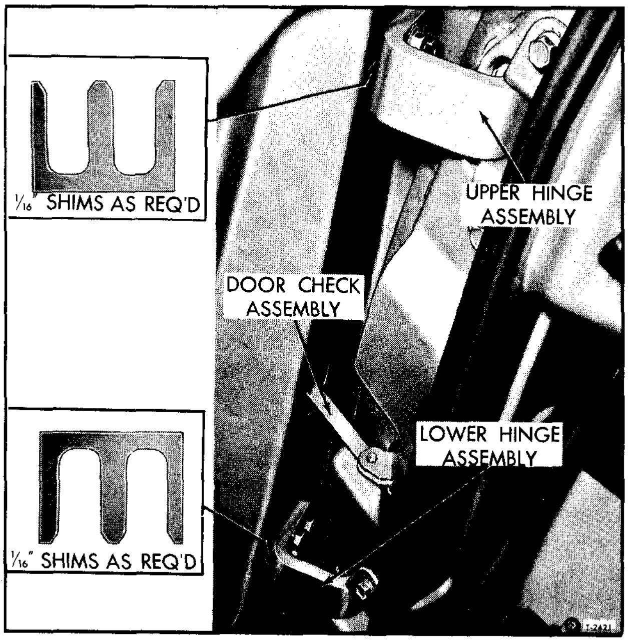


Figure 5—Cab Door Hinges and Check Link Installed

DOOR ADJUSTMENTS

Doors can be adjusted for alignment or clearance in the cab door opening (fig. 6), and for proper latching. Door alignment adjustments are made at the striker bolt, and at door hinges. Rubber seal around door should be lubricated with silicone

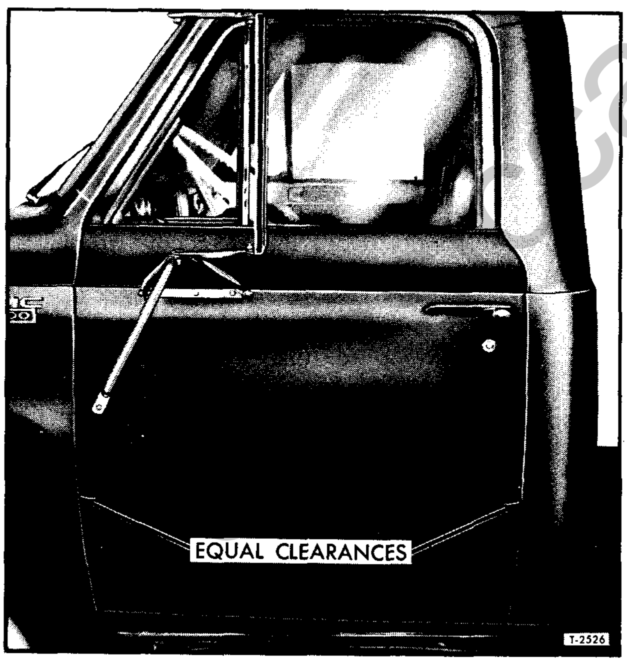


Figure 6—Door Clearances

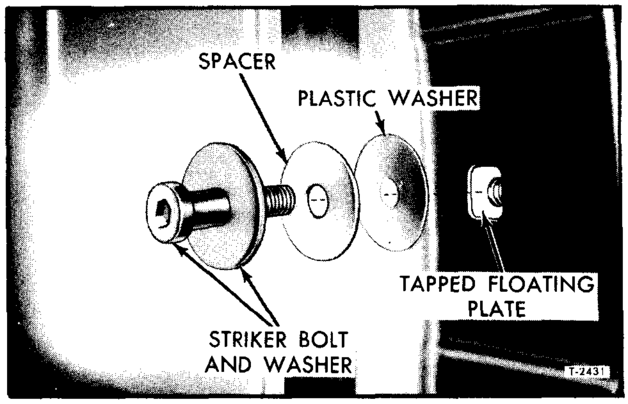


Figure 7—Door Striker Bolt and Washers

lubricant and door vent window should be open before opening and closing door while making door adjustment. If door has been replaced, adjustments should be made in sequence described in the following paragraphs:

Before adjusting hinges, always remove the striker bolt from the cab pillar.

NOTE: Horizontal slotted cap screw holes in door half of hinge provide the "in" and "out" adjustment of door. See figure 5.

The fore and aft adjustment of door is provided by the removal or installation of shims inserted between door and hinge strap (fig. 5).

The door, when properly located in door opening, will have equal clearance around its perimeter.

TO POSITION DOOR FORE AND AFT

At only one hinge at a time, loosen three capscrews which attach hinge strap to door. Add shim to increase clearance at door leading edge or remove shim (if used) to decrease clearance.

Repeat adjustment at other hinge if necessary. NOTE: A condition may exist where the removal or installation of shim at only one of the hinges may be necessary.

Door should have equal clearances at both front and rear. After making adjustment, tighten hinge screws firmly. Install striker bolt as directed later.

TO POSITION DOOR "IN" OR "OUT" OF CAB OPENING

Loosen three cap screws which attach each hinge strap to door. Reposition door on hinge straps so that door outer surface is flush with cowl surface.

Perform clearance adjustment at rear of door as directed later under "Door Striker." See "Door Rear Edge "In" or "Out" Adjustment."

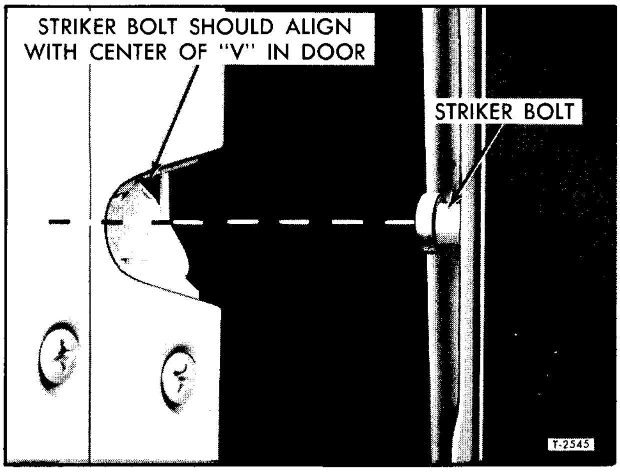


Figure 8—Sight Checking Striker Bolt Alignment

DOOR STRIKER

The door striker consists of a special bolt and washer assembly which is threaded into a tapped, floating cage plate located behind the cab lock pillar as shown in figure 7. The door is secured in closed position when the lock cam in door engages and snaps-over the striker bolt. Striker bolt can be replaced or adjusted as directed under applicable headings.

NOTE

Periodically check tightness of striker bolt.

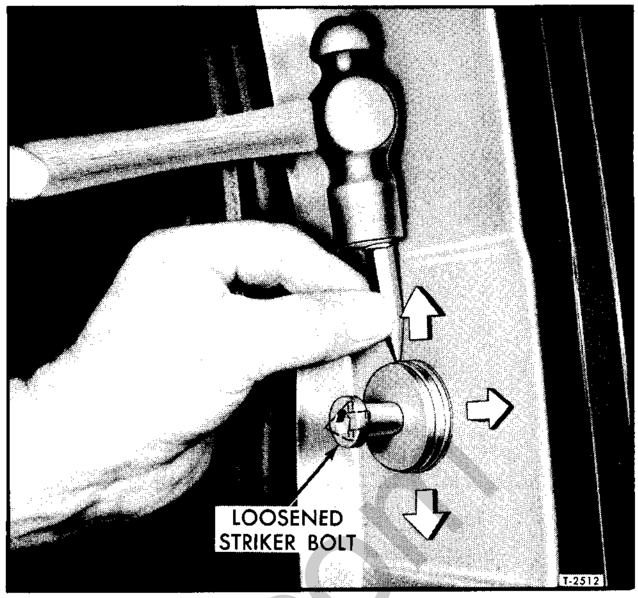


Figure 9—Relocating Striker Bolt

STRIKER BOLT REPLACEMENT

Removal (Refer to Fig. 7)

1. Mark position of striker bolt spacer or washer on door pillar using pencil or crayon.
2. Insert a 5/16-inch hex wrench into head of striker bolt, then turn bolt counterclockwise from plate in cab pillar.

Installation (Refer to Fig. 7)

1. To install, reverse the "Removal" procedure.

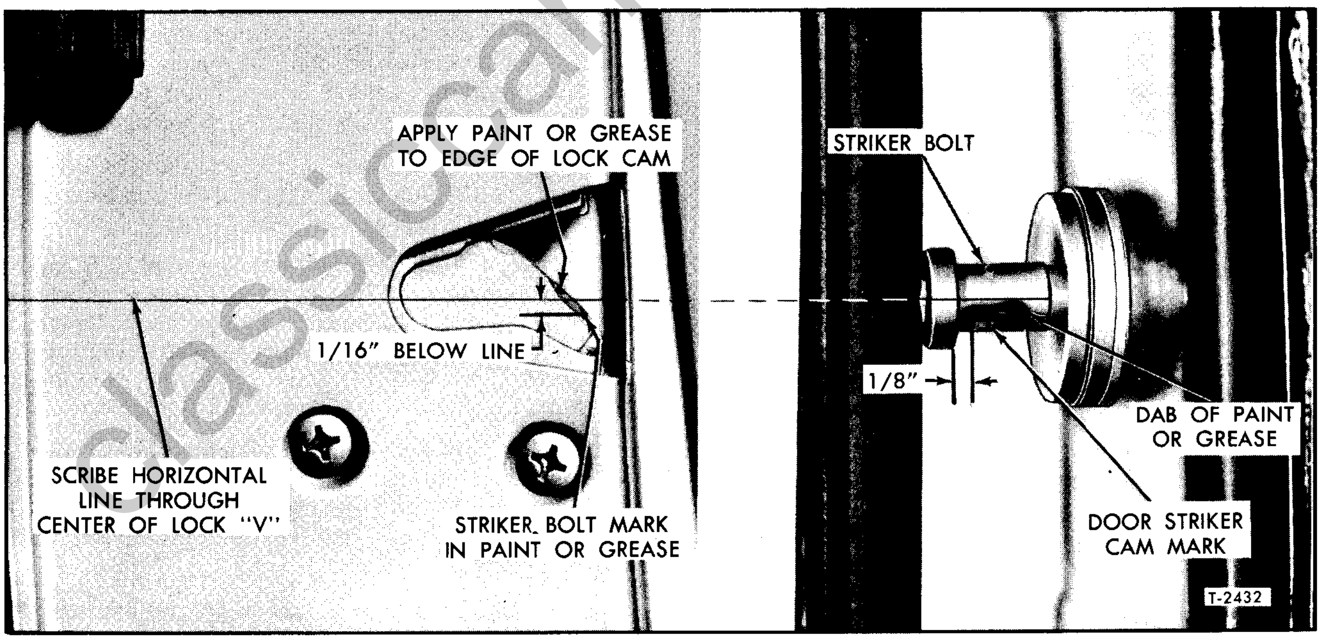


Figure 10—Striker Bolt Alignment Points

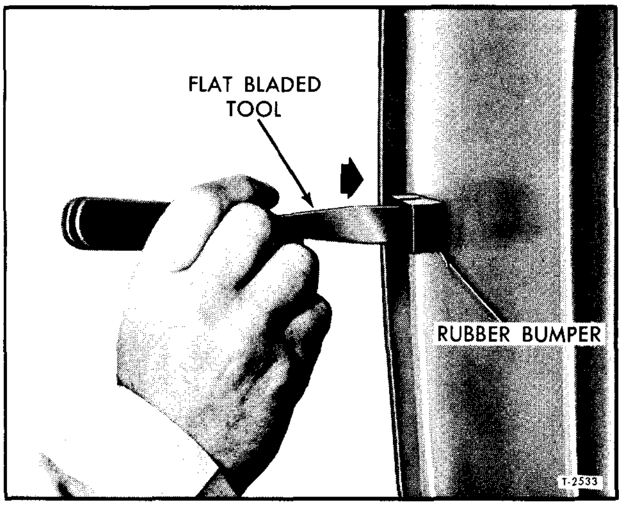


Figure 11—Installing Rubber Bumper in Door

NOTE: Make sure the thin plastic washer is positioned against the painted door opening pillar and center the bolt washer within marks on pillar.

2. If door has been removed and then installed or aligned in opening, the door should not be closed completely until a visual check is made to determine if lock cam in door will engage the striker bolt correctly. Center of striker bolt should be in direct alignment with "V" slot in door. See figure 8. If necessary, reposition striker bolt as directed below under "Striker Bolt Adjustment."

STRIKER BOLT ADJUSTMENT

IMPORTANT: This adjustment should be checked and if necessary adjusted after door is aligned properly in cab opening.

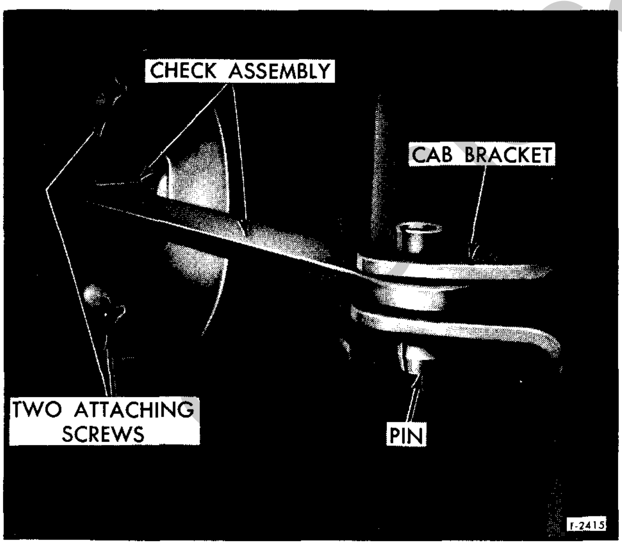


Figure 12—Door Check Installed

Figure 13—Door Weatherstrip Installed

NOTE: Striker bolt on cab pillar is adjustable vertically and transversely as shown in figure 9 after loosening the bolt with a 5/16-inch hex wrench. The bolt fore and aft adjustment is obtained by use of shim spacers located between the bolt washer and the cab pillar. Figure 7 illustrates location of bolt, washers and spacer.

Striker Bolt Fore and Aft Adjustment

1. To check striker bolt for proper fore and aft adjustment, smear grease or paint to contact side of bolt as shown in right view of figure 10.

2. Slowly close door until lock cam of door just contacts the side of striker bolt and makes an impression in the grease or paint.

3. Measure distance between head of bolt and the cam impression in grease. Distance should measure 1/8-inch as shown in right view of figure 10. This dimension is necessary to assure that the head of striker bolt will ride at center of nylon shoe which is located just in back of the lock cam.

To obtain this dimension, remove the striker bolt and install or remove shim spacers. Spacers are available in two thicknesses; 5/64-inch and 5/32-inch. Make sure the thin plastic washer is located next to cab pillar.

After obtaining proper fore and aft adjustment, tighten bolt snug only at this time and then proceed with the "Striker Bolt Height Adjustment."

Striker Bolt Height Adjustment

This adjustment is important to assure that the right proportion of door's weight will rest on striker bolt when door is closed. If bolt is positioned too high on pillar, rapid wear will occur to the lock cam; if too low, an extra load will be placed on door hinges as well as pull door downward and out of alignment. Tighten striker bolt.

Generally the striker bolt height adjustment can be checked quite accurately by just sighting the center of "V" slot on door with the center of striker bolt as illustrated in figure 8. However, to make a more positive check, perform the following:

1. Mark a horizontal line through center of "V" slot and on door lock cam as shown in left view of figure 10.
2. Smear some grease or paint on contact edge of lock cam as shown in same view.
3. Slowly close door until cam barely contacts the striker bolt to leave an impression in grease. Open door and check contact mark on edge of cam. Mark should be located approximately 1/16-inch below the horizontal mark if properly aligned.
4. If necessary, raise or lower the loosened striker bolt up or down by tapping on the washer or spacer at base of striker bolt as shown in figure 9. DO NOT TAP ON HEAD OF BOLT.

NOTE: If striker bolt reaches end of adjustment travel it will then be necessary to add or remove shims at the door hinges.

After obtaining proper height adjustment, proceed to make "Door Rear Edge "In" or "Out" Adjustment."

Door Rear Edge "IN" or "OUT" Adjustment

This adjustment is for purpose of aligning the rear surface of door flush with adjacent surfaces of cab. If surfaces are not flush, proceed as follows:

1. Mark a horizontal line on cab pillar at top of striker bolt base washer or spacer.
2. Loosen striker bolt slightly, then tap against bolt base washer, to move bolt "in" or "out" as necessary to locate door surface flush with cab surface when door is closed. Before tightening the striker bolt make sure top of bolt base washer is contacting the horizontal mark on cab pillar. Final tighten striker bolt.

NOTE: Two rubber bumper blocks are inserted into door rear edge panel to absorb closing shock and to limit the "in" adjustment. If bumper blocks are deteriorated or damaged otherwise, they should be replaced. Pull blocks from door to remove. A flat-bladed tool, such as a putty knife, can be used for installing blocks in manner shown in figure 11.

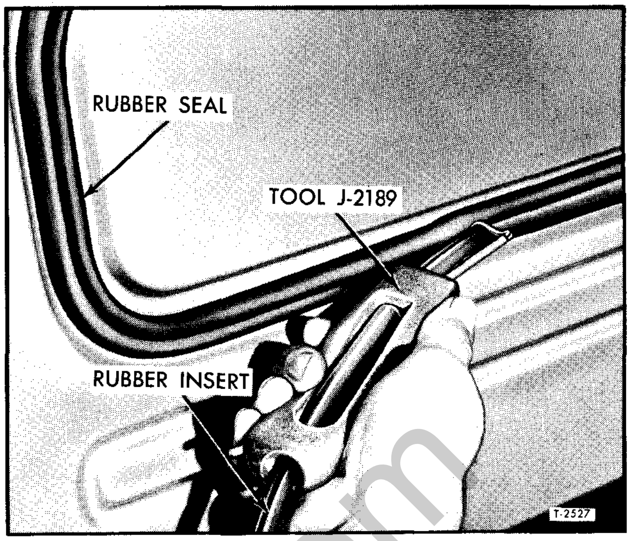


Figure 14—Installing Access Panel Insert

DOOR CHECK REPLACEMENT

IMPORTANT

Do not allow door to swing beyond the normal full-open position when the check strap is disconnected or removed.

NOTE: Refer to figure 12.

1. Using a small punch, drive spring pin up from bottom of strap bracket.
2. Remove the two screw and washer assemblies which attach the check strap catch to door. Remove check assembly.

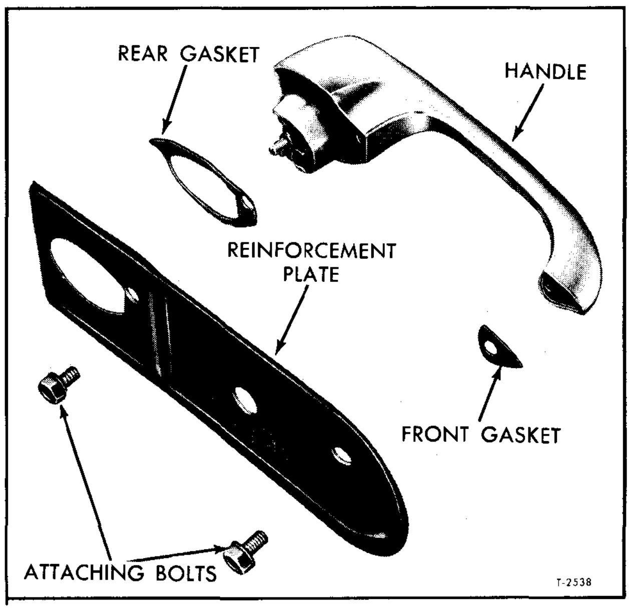


Figure 15—Door Handle Installation

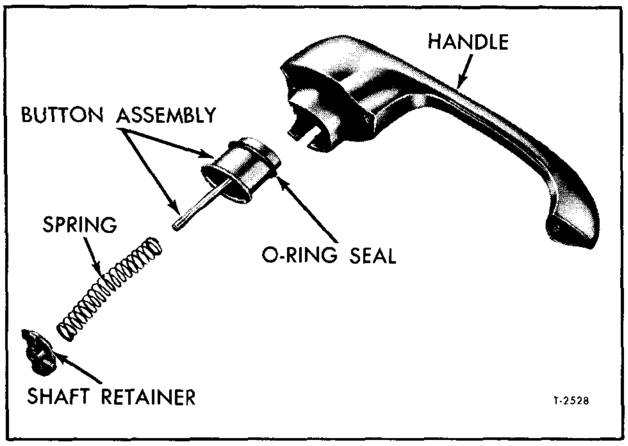


Figure 16—Door Handle Disassembled

3. Attach check assembly to door, then connect check strap to cab bracket with spring pin, which must be installed from top side.

DOOR WEATHERSTRIP REPLACEMENT

NOTE: Door weatherstrip is retained to cab opening with adhesive cement as shown in figure 13. Weatherstrip at bottom of door opening is retained by the sill plate as shown.

1. Remove weatherstrip, then scrape all old cement from cab flange.

2. Apply cement to cab flange surfaces, then position seal to cab. Referring to figure 13, note the installed position of seal ends of the door weatherstrip. Also note the position of the cut ends of weatherstrip in cab opening.

3. After installing weatherstrip in cab opening, install sill plate.

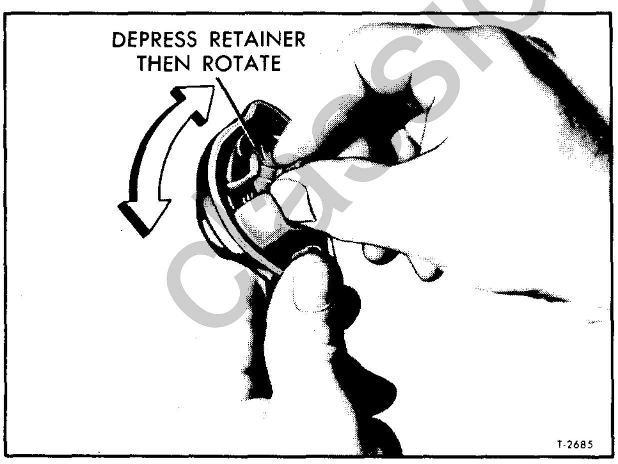


Figure 17—Disengaging Handle Spring Retainer

DOOR ACCESS PANEL REPLACEMENT

REMOVAL (Refer to Fig. 14)

1. Pry end of small rubber insert out of retainer seal groove with a pointed tool, then pull insert completely out of seal.
2. Engage hook end of tool J-2189 under edge of access panel, then run hook along panel to force panel out of rubber seal.
3. Pull seal from door.

CAUTION: INSIDE EDGE OF OPENING MAY BE SHARP. DO NOT ATTEMPT TO PERFORM OPERATIONS THROUGH OPENING UNLESS SHARP EDGE IS REMOVED.

INSTALLATION

1. Position rubber seal around opening in door.
2. Place access panel to seal, then with hook end of tool in panel groove of seal, move tool around panel to force outer lip of seal over edge of panel.
3. Thread end of small rubber insert through handle and loop of installer tool (fig. 14). Push tool loop and end of insert into groove of seal. Feed in rubber insert, while proceeding around panel. Use a hitching movement of tool to avoid elongation of insert. If new insert strip is being used, cut off insert allowing sufficient overlap for a tight joint, then butt into seal groove.

DOOR OUTSIDE HANDLE REPLACEMENT

NOTE: Refer to figure 15.

1. Remove the access panel from lower portion of door as directed previously under "Door Access Panel Replacement."
2. Roll window to top of door, then using a 7/16-inch wrench, reach up through access opening and remove two lock-type screw and washer assemblies which attach handle to door. Remove handle and handle gaskets.
3. Install door handle, using procedures in reverse of handle removal. Make sure the handle reinforcement plate is in position, inside of door at handle mounting.

DOOR HANDLE PUSH BUTTON AND SHAFT REPLACEMENT

DISASSEMBLY (Refer to Fig. 16)

1. Remove handle from door as directed previously under "Door Outside Handle Replacement."
2. Remove the button shaft retainer by first depressing, then rotating retainer as shown in figure 17. Remove shaft spring and button assembly with O-ring seal from handle.

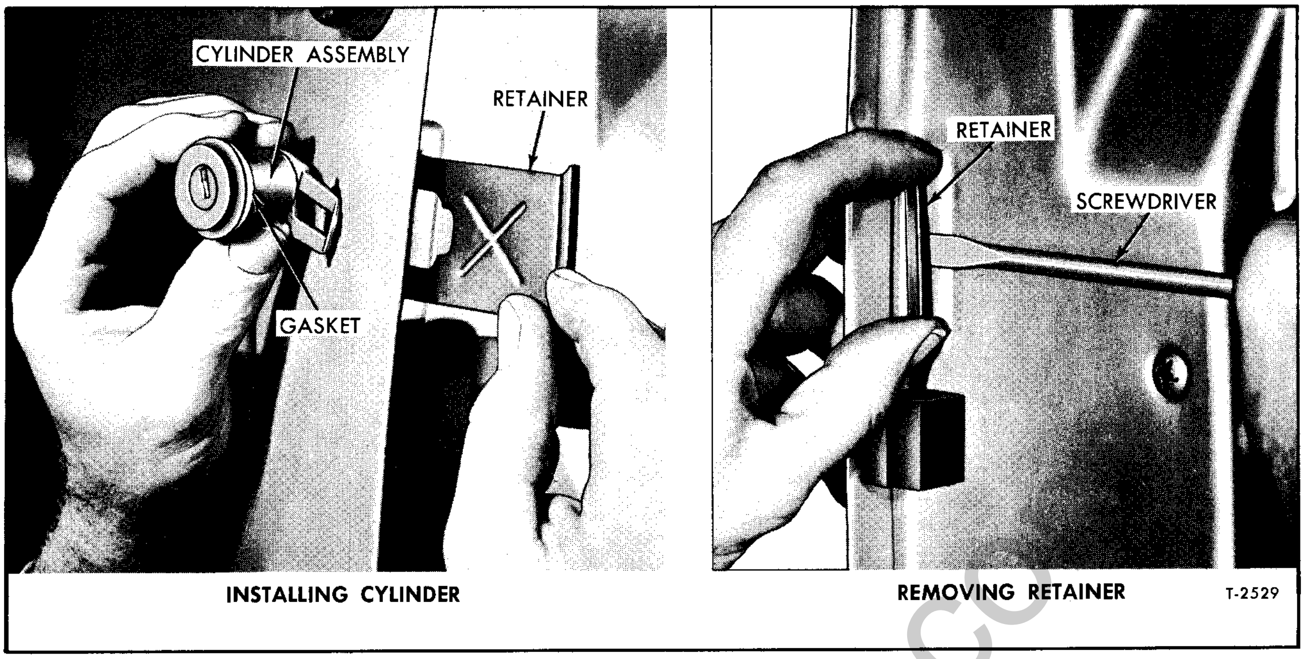


Figure 18—Door Lock Assembly Replacement

ASSEMBLY

1. Place button assembly with installed O-ring seal in handle.

2. Locate spring over button shaft, then install spring retainer (fig. 17).

DOOR LOCK CYLINDER REPLACEMENT

(Refer to Figure 18)

REMOVAL

1. Using flat blade screwdriver, pry retainer from edge of door as shown in figure 18.

CAUTION: HOLD ON TO RETAINER WHEN REMOVING AS RETAINER MAY FLY FROM POSITION.

2. Remove the lock cylinder from door.

NOTE: Cylinder must be rotated and tilted slightly to permit cylinder lug to disengage from lock mechanism stud. Remove lock cylinder gasket.

INSTALLATION

1. With gasket in position on lock cylinder, insert cylinder into door to engage cylinder lug over lock mechanism stud within door.

2. While holding cylinder in door, force the cylinder retainer through slot at edge of door to engage grooves at side of cylinder body. NOTE: It may be necessary to drive the retainer into final engagement with a light hammer. Make sure both legs of retainer are engaged in grooves of lock cylinder. If one of the retainer legs is not engaged, the retainer flange will not be vertical in door slot.

DOOR INSIDE HANDLES REPLACEMENT

NOTE: If removing door lock inside handle, the handle position should be marked in relation to door panel to assure that handle is installed later at the same operating angle. See figure 19 which shows proper handle position.

REMOVAL

1. Insert tool (J-9886) between handle flange and escutcheon plate as shown in figure 19.

2. Force lock spring from grooves in base of door handle. DO NOT LOSE SPRING. Remove handle and escutcheon plate.

NOTE: The lower view in figure 19 shows how the tool engages the clip at underside of handle when removing.

INSTALLATION

1. Replace cork washer, if damaged.

2. Insert lock spring in handle grooves from direction shown in figure 19.

3. Place the escutcheon plate on handle spindle.

4. If installing door lock release handle, make sure handle is in position previously marked on door inner panel. To install either handle, force handle with installed lock spring over spindle until lock spring becomes fully engaged.

DOOR LOCK AND REMOTE CONTROL MECHANISM REPLACEMENT

NOTE: Figure 20 illustrates the components of the lock and remote control mechanism.

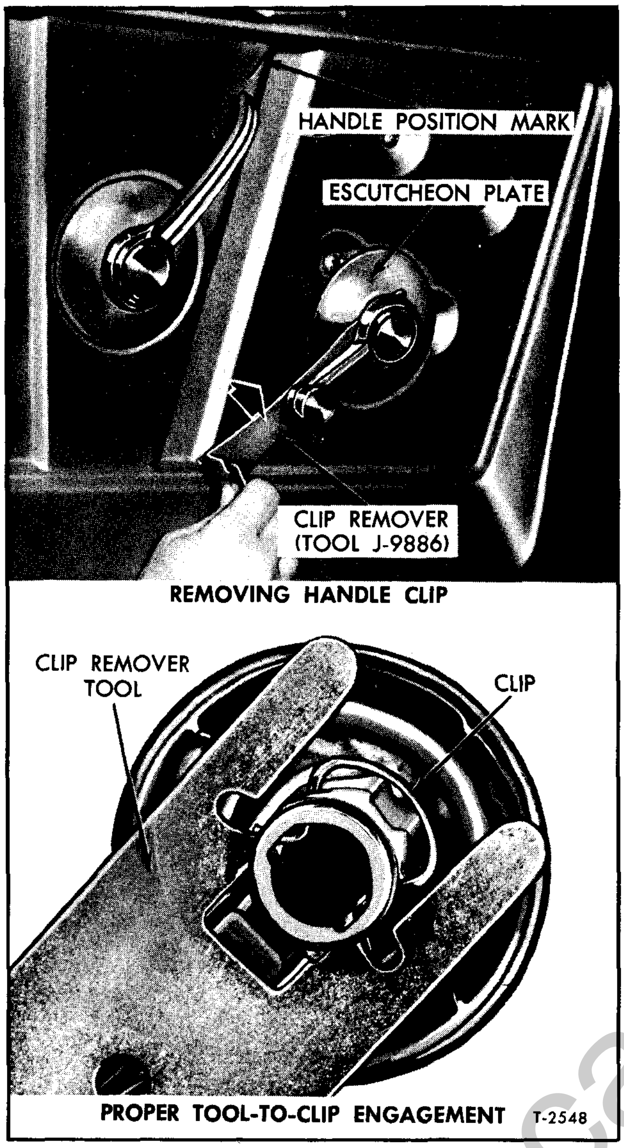


Figure 19—Door Inside Handle Replacement

REMOVAL

1. Remove the door inside lock knob which is threaded on lock rod.
2. Remove the access panel from door inner panel as directed previously under "Door Access Panel Replacement."
3. Remove the door lock inside handle as directed previously under "Door Inside Handles Replacement."
4. Remove three screws which attach the remote control to door inner panel. Lower the control to door access opening, then disengage fastener at pull-rod. Separate rod from control.
5. Remove the lock cylinder assembly from outer side of door as directed previously under "Door Lock Cylinder Replacement."
6. At rear edge of door, remove three special

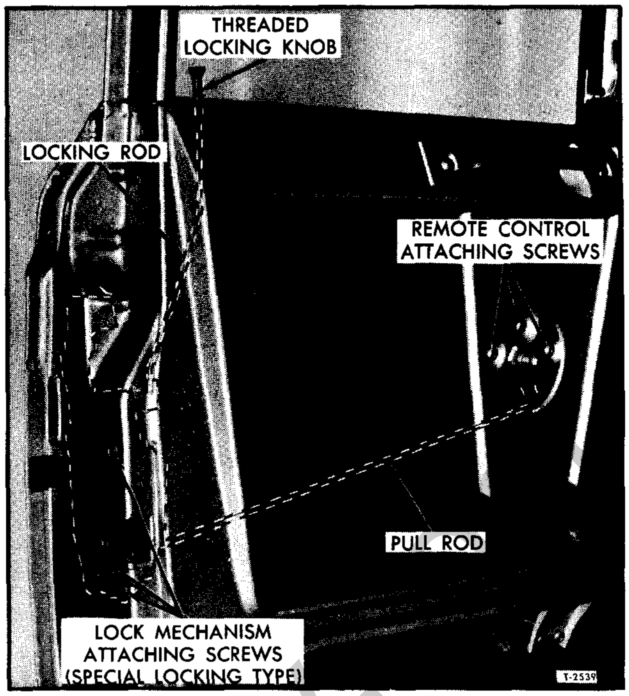


Figure 20—Door Lock Mechanism and Rods

locking-type screws which attach lock mechanism to door frame. Lower the lock and attached two rods out through access opening in door.

7. Separate rods from lock mechanism if desired. To disengage pull-rod fastener, force lock tab of fastener outward through small hole in lock release lever as shown in figure 21, then slide fastener from lever.

INSTALLATION

Install lock mechanism with rods and remote control in reverse of the "Removal" procedures.

IMPORTANT: Make sure to use the three special locking-type screws which attach lock mechanism to door frame.

DOOR VENT GLASS ONLY REPLACEMENT

NOTE: This procedure covers replacement of the vent glass only.

1. Squirt gasoline on rubber filler all around glass frame to soften old filler. When seal softens sufficiently, pull glass and old filler from glass channel.
2. Thoroughly clean the inside of the glass channel with sandpaper to remove all rust and foreign matter.

NOTE: Ventilator glass rubber filler is supplied in two thicknesses - 0.067" and 0.080" - to permit installation in any vehicle without use of special tools.

3. Cut new piece of glass channel rubber filler,

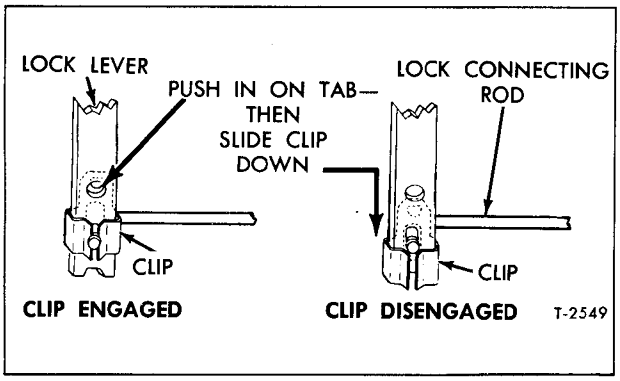


Figure 21—Disengaging Door Pull Rod Fasteners

two inches longer than required. Position filler (soapstoned side away from glass) over that part of glass which will be inserted in frame. Punch together extra projecting length of filler at each end to retain filler in place during installation.

4. Brush inner channel of glass frame with light engine oil. Press glass and filler into frame until firmly seated.

NOTE: Purpose of engine oil is two-fold; as a lubricant to facilitate assembly, and to soften and expand filler to create a water-tight seal. However, latter effect requires 24 hours; therefore, water-leak test should not be made before this time has elapsed.

5. Trim off excess filler material around frame and at end of frame.

DOOR VENT WINDOW TENSION ADJUSTMENT

Vent windows are of friction type having a theft-resistant latch. Friction mechanism consists primarily of a coil spring mounted on vent window lower pivot, which exerts frictional force against mounting lower support.

If friction mechanism is adjusted too tight, it will be difficult to open or close vent. Too loose an adjustment will result in a fluttering vent or one having a tendency to close with wind pressure.

If necessary to change vent friction, perform procedures as follows:

1. Remove access panel from door inner panel as directed previously under "Door Access Panel Replacement." Panel is retained to door with rubber insert-type retainer.

2. Reaching up through access opening in door, as shown in figure 22, turn adjustment nut with a 9/16-inch speed wrench to obtain five to seven pounds torque, while moving vent window from a ten degree open position to a full-open position. Use either a push or pull type spring scale, positioned at rear edge of vent glass. Turning adjustment nut clockwise increases operating tension.

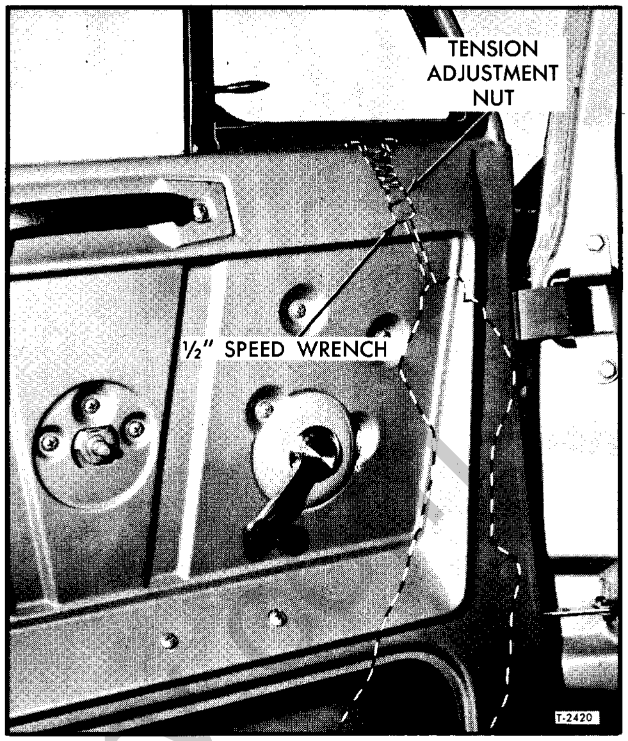


Figure 22—Adjusting Vent Window Tension

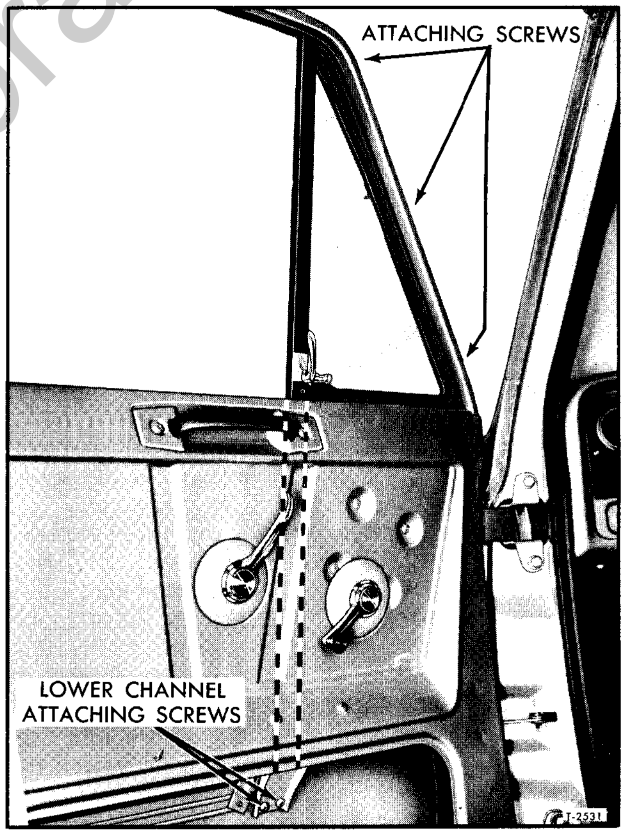


Figure 23—Vent Window Attachment

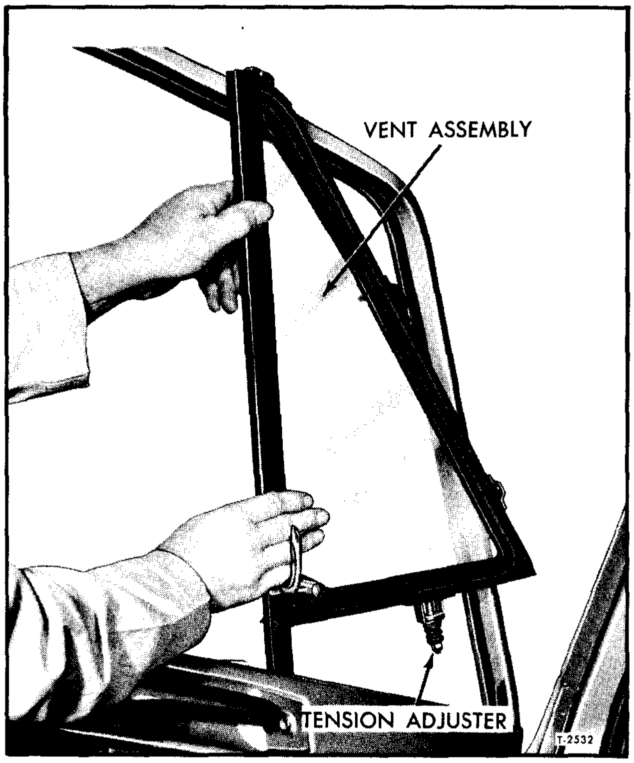


Figure 24—Replacing Vent Window

Turn nut counterclockwise to decrease tension.

3. Install door access panel.

DOOR VENT WINDOW ASSEMBLY REPLACEMENT

REMOVAL

NOTE: The channel between the door window glass and the door vent is part of and is removed with the vent window assembly.

1. Regulate the window to the full down position.
2. Remove the access panel from door inner panel as directed previously under "Door Access Panel Replacement."
3. Referring to figure 23, remove lower two channel retaining screws from door inner panel bracket.
4. Referring to figure 23, remove three screws which attach vent framing to door.
5. Referring to figure 24, rotate the vent window assembly and carefully lift it up and out of door.

INSTALLATION

1. With window glass down, lower the glass channel portion of vent assembly down into the door and rotate it to locate in position (fig. 24).
2. Make sure that the rubber lip around forward portion of vent is properly mated over door vent opening contours.
3. Install two screws attaching lower channel portion of vent assembly to door inner panel bracket (fig. 23).
4. Referring to figure 23, install three screws to attach vent frame to door structure.
5. Adjust the vent opening and closing tension as directed previously under "Door Vent Window Tension Adjustment."
6. Install door access panel.

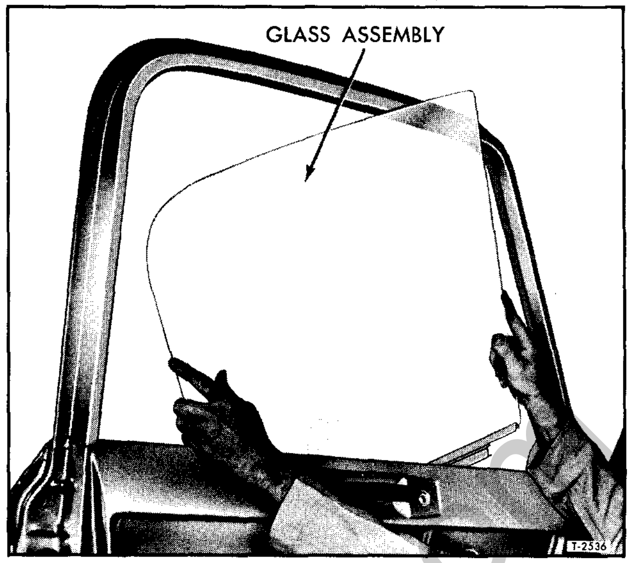


Figure 25—Replacing Door Window Glass Assembly

DOOR WINDOW GLASS REPLACEMENT

REMOVAL

1. Remove the vent window assembly as directed previously under "Door Vent Window Assembly Replacement."
2. Regulate window to two-thirds closed position.
3. Disengage the glass from the regulator guide by positioning the roller at the guide openings and then lifting out the window (fig. 25).
4. If desired, the horizontal seal strips can be replaced using a pointed instrument to pry strips from door as shown in figure 29.
5. Also if desired, the door glass run channel assembly can be removed at this time. Pull run channel from door.
6. To replace the glass in glass channel perform the following:

a. Squirt gasoline along glass filler on both sides of glass to soften seal. Remove glass from channel when filler is sufficiently soft. Pull rubber filler from channel.

b. Thoroughly clean inside of glass channel, removing all rust and foreign matter.

c. Window glass rubber filler is supplied in three thicknesses - 0.037", 0.047", and 0.057" -

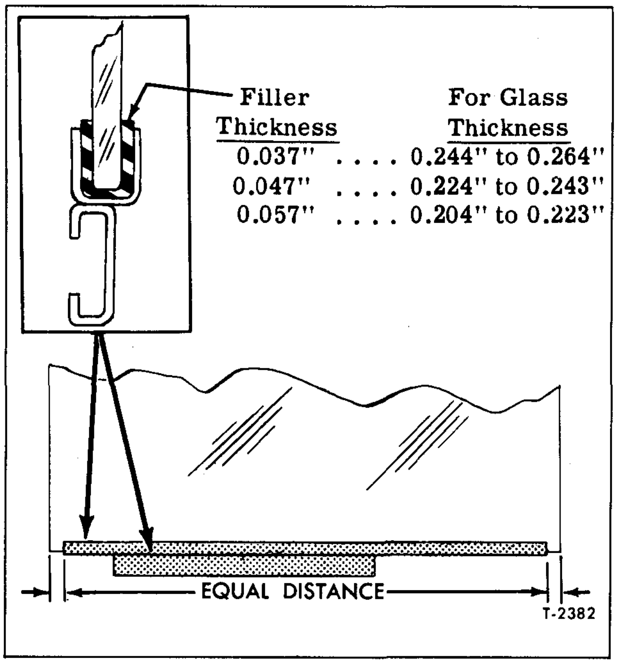


Figure 26—Door Window Glass Assembly

to permit installation in any vehicle without special tools.

d. Cut new piece of channel filler slightly longer than channel. Position filler (soapstone side away from glass) around glass.

e. Brush inside of channel freely with light engine oil.

f. Press channel on filler and glass until firmly seated.

IMPORTANT: Make sure channel ends are equal distance from edge of glass (fig. 26) and that regulator arm slot in channel, is facing the right direction in respect to rounded and squared corners at upper edge of glass. Trim off excess filler material along channel and at ends.

INSTALLATION

1. If glass run channel was removed from door framing, install channel by pressing run channel into place around door frame.

2. If the glass horizontal seal strips were removed from door, press new seal strips into position making sure all strip attaching clips are fully engaged.

3. Lower the door window assembly into door (fig. 25).

4. Engage glass channel on the roller of regulator arm. NOTE: Regulator arm should be in the window two-thirds closed position.

5. Install vent assembly as directed under "Door Vent Window Assembly Replacement."

6. Check operation of vent assembly and window raising and lowering action for possible binding.

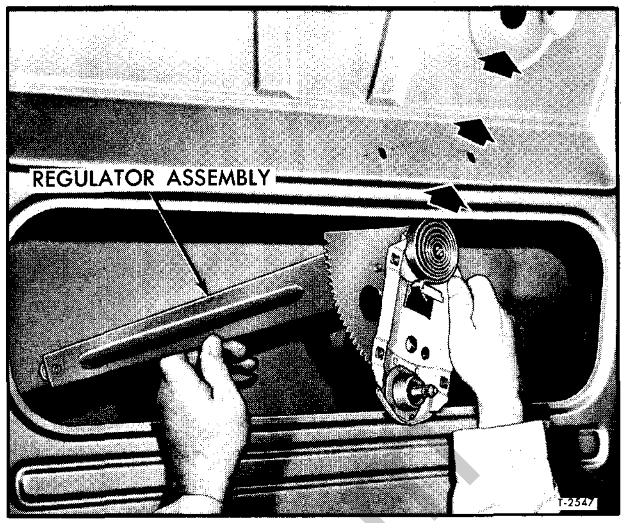


Figure 27—Replacing Door Window Glass Regulator

DOOR WINDOW REGULATOR REPLACEMENT

NOTE: To replace regulator, it is first necessary to remove the door window assembly and the vent window assembly as directed previously under "Door Window Glass Replacement."

1. Remove regulator handle.

2. Remove four screws which attach regulator to door inner panel.

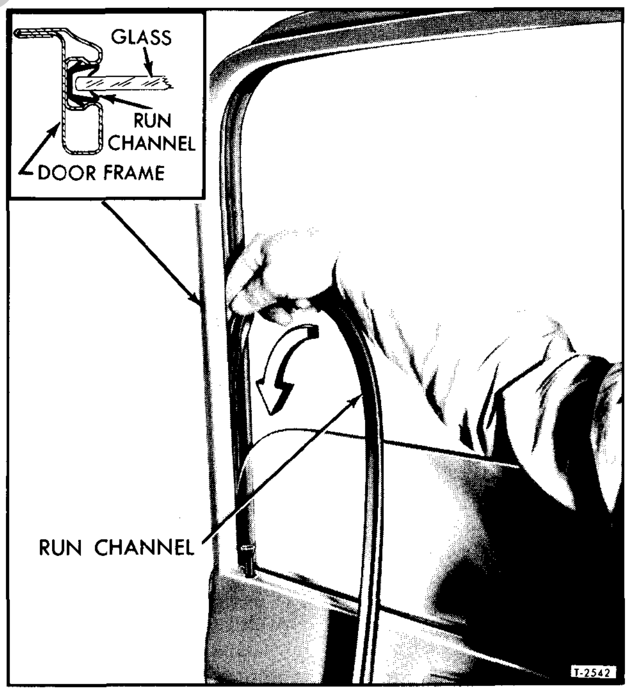


Figure 28—Installing Window Glass Channel Run

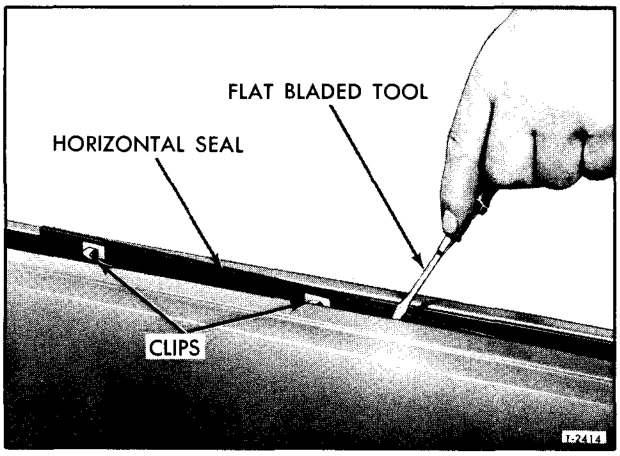


Figure 29—Removing Glass Horizontal Seals

3. Referring to figure 27, remove regulator.
4. To install regulator, perform the "Removal" procedures in reverse sequence. Replace cork washer, if damaged.

DOOR GLASS RUN CHANNEL REPLACEMENT

REMOVAL

1. Roll window to bottom of door.
2. At upper end of channel, next to vent window frame, pry end of channel from door using a small flat bladed instrument.
3. Continue to pull channel downward from top of door, then upward to remove from side frame of door.

INSTALLATION

1. Apply thin coat of silicone type lubricant to back and sides of run channel.
2. Start end of run channel into door side frame, then force it downward in manner shown in figure 28. By engaging length of channel required to butt against vent window frame, the amount of channel to be inserted downward can be determined. Use thumbs to press channel into position.

NOTE: The run channel can be inserted downward more readily if the window is rolled up and down during the process.

If run channel cannot be installed as instructed, it will then be necessary to remove the door window glass.

DOOR WINDOW GLASS HORIZONTAL SEALS REPLACEMENT

NOTE: Refer to figure 29.

1. Remove the vent window and door window as directed previously under applicable headings.
2. Using a thin flat bladed instrument, pry seals from door panel in manner shown. Pry a small amount at each fastener to prevent seal channel distortion.
3. To install, press seal assembly evenly into door panel.
4. Install door glass.

CAB REPLACEMENT

REMOVAL

NOTE: Necessary equipment for efficient and safe replacement of cab consists of a chain hoist (3/4-ton minimum capacity), a sling having padded hangers, and two or more support blocks to rest cab on once the cab is removed from chassis.

1. Disconnect the battery.
2. Remove the hood panels.
3. Drain cooling system if equipped with heater and disconnect heater hoses at cab cowl.
4. If equipped with air brakes, exhaust the pressure from air system.
5. Disconnect all necessary wiring harnesses and cables from cab or chassis.
6. If air conditioned, refer to "AIR CONDITIONING" (SEC. 1D), open system and cap lines observing precautions found in above references.
7. Detach and/or disconnect all lines between cab and chassis. NOTE: Do not attempt to salvage clutch or brake hydraulic fluid.
8. Disconnect accelerator linkage at cab cowl.
9. Disconnect mechanical parking brake.
10. Remove closure panel from cab floor at transmission shift lever.
11. Disconnect speedometer cable at transmission or at the dash unit.
12. Mark for alignment purposes later, the steering shaft joint flange-to-steering gear shaft, then remove the flange clamp bolt. When cab is raised later, this connection will separate.
13. Remove the cab mounting bolts.
14. With a hoist sling device having padded hangers, engage hangers to cab door openings WITH DOORS PARTLY OPEN.

NOTE: If sling device of type described above is not available, a solid hardwood 4 x 4, 7-1/2 feet long, positioned through the cab with hoist chain attached securely to each end, can be used.

15. Raise cab and remove from chassis.

INSTALLATION

1. Place cab mounting components in position on chassis frame brackets. Refer to figures 2 and 3 for location of mounting components.

NOTE: If desired, masking tape can be applied to retain loose parts temporarily in position.

2. Carefully lower the cab to chassis and at same time engage the steering shaft to gear shaft using marks made prior to removal for alignment.

Tighten shaft clamp bolt or bolt nut to foot-pounds torque as indicated in STEERING SYSTEM (SEC. 9) of this manual.

3. Install balance of cab mounting components.
4. Connect speedometer cable.
5. Connect hand brake if mechanical.
6. Connect accelerator linkage.
7. Connect all control and gauge lines.
8. Connect fuel line if previously disconnected.
9. Connect heater hoses if used, then fill cooling system.
10. Service the hydraulic brake system, if used.
11. Service the clutch hydraulic system. Use new fluid.
12. Connect all electrical wiring.
13. Refer to "AIR CONDITIONING" (SEC. 1D) for service of the air conditioning system, if installed.
14. Connect battery cables.
15. Install hood panels and align, if necessary. Refer to SHEET METAL (SEC. 11) of this manual.
16. Recheck all connections of wiring, lines, and control linkage.
17. With wheels blocked as a safety measure, start engine, then final check all connections and linkage.

CAB HEATING AND VENTILATION (CONVENTIONAL CAB MODELS)

The air-flow type heater (fig. 30) is used on conventional cab models covered by this manual. All heater components are located within the cab, under the instrument panel.

Service diagnosis information is explained later in this section.

The air-flow heater operates on full outside air and has a three lever control panel and a blower motor control switch on dash panel.

Temperature control is by means of the air-mix method; mixing heated outside air which has passed through the heater core and outside air which has by-passed the core in proportions necessary to provide the desired temperature. The control on dash for this purpose is marked "TEMP." With lever to the left, all the incoming air by-passes the heater core. With lever to the far right, all outside air must pass through the core, thus providing maximum heat. When lever is positioned part way, part tempered and part untempered air passes through the heater.

The control on dash marked "AIR" regulates the flow of outside air which passes through the heater and into cab. This control must be positioned all the way towards the right in order to obtain heat.

IMPORTANT: Do not operate the blower motor when "AIR" control lever is in the full left position. The heater fan speed is controlled by moving blower switch lever from left to right positions "OFF-LOW-SPEED, MEDIUM SPEED - and HIGH SPEED."

The "DEFROST" lever controls flow of air to the windshield defroster ducts. With knob all the way to the right, entire heater output is diverted to the defroster ducts for defrosting.

For warm weather ventilation, place "DEFROST" and "TEMP." control knobs in extreme left positions, move "AIR" knob to extreme right, then place fan switch lever to desired fan speed position. The fan speed control resistor unit is attached to the blower shroud with two screws. If resistor should become defective, the result will be high speed blower motor operation with blower switch lever in both the "LOW" and "MEDIUM" speed positions.

HEATER UNIT REPLACEMENT

(Refer to Figure 30)

REMOVAL

1. Drain cooling system to just below level of heater core.
2. Mark hoses for identification then disconnect hoses at heater core fittings.
3. At front side of cowl, remove single bolt which attaches the heater blower bracket to cowl.
4. At rear side of heater core housing, remove the small spring-type retaining washer from "TEMP." control lever, then remove the control wire clamp screw. Pull wire from lever.
5. At top of blower motor, disconnect the "AIR" control wire in same manner.
6. Disconnect the blower adapter-to-air distributor hose.
7. At top of blower housing, near the cowl, separate the wiring connection at the blower speed control resistor.
8. Separate wiring connector at rear of blower motor. Pull rearward on connection.
9. Underneath instrument panel, at right side of core, remove four bolts which attach heater unit to cowl extension.
10. Remove single bolt which attaches heater support bracket to bottom instrument panel. This same bolt attaches the blower motor ground wire.
11. Using care not to damage heater unit, work the unit rearward and down from compartment.
12. If desired, the unit can be readily disassembled for inspection or replacement of the blower, motor, core, etc.

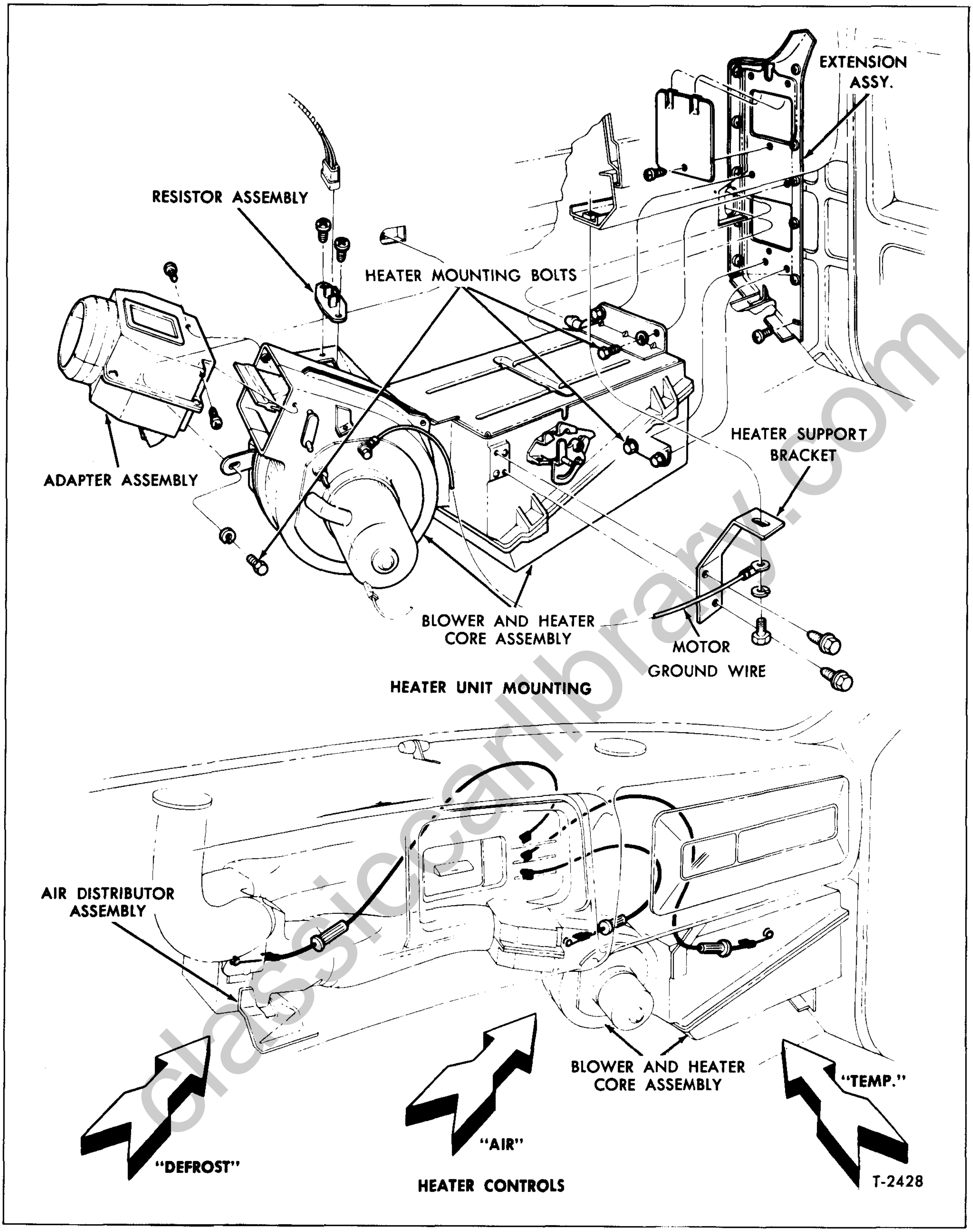


Figure 30—Air Flow Heater

INSTALLATION

1. Make sure the cellular dust pad is located over heater core water inlet and outlet pipes.
2. Place the heater core and blower assembly into position, then install all attaching bolts.

IMPORTANT: Make sure blower motor ground wire is sandwiched under head of heater support bracket attaching bolt at instrument panel.

3. Connect wiring at blower speed control resistor unit and also at the blower motor. Make sure connections are secure.
4. Connect the blower air outlet tube.
5. Connect the "AIR" and "TEMP." controls to heater assembly. Lower view in figure 30 shows connections.
6. Referring to identification marks made on heater hoses prior to disconnecting, connect the hoses to respective heater core piping.

IMPORTANT: Make sure the 5/8" I.D. hose is connected to small core pipe and that the ¾" I.D. hose is attached to the larger pipe. If hoses are not installed as directed, poor heat output and/or a ruptured heater core will result. The core internally is designed to accept the higher pressure at the inlet (5/8" I.D. pipe) side of core only.

7. Replenish coolant in system, then start and operate engine until normal operating temperature is obtained.
8. Check for possible leakage and check the operation of heater and controls.

AIR DISTRIBUTOR REPLACEMENT

(Refer to Figure 30)

The air distributor can be readily replaced after disconnecting the attaching air hoses and the "DEFROST" control wire, then removing the three screws which attach distributor to dash and cowl.

HEATER CONTROL CABLE ADJUSTMENT

Each control wire conduit is equipped with a threaded-sleeve (fig. 31) which can be turned to obtain full opening and closing of air doors and to even up the heater knobs on control panel. Make adjustment to control wire conduit if desired.

SERVICE DIAGNOSIS

POOR OR NO HEATING

1. Heater hoses are kinked, deteriorated, or switched around at the core piping.
2. Heater core plugged.
3. Poor blower motor ground connection.
4. Blower malfunctioning.

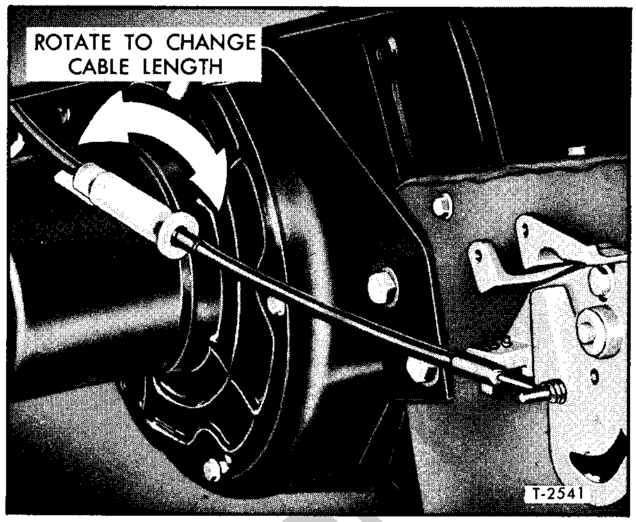


Figure 31—Heater Control Cable Adjustment Sleeve

BLOWER INOPERATIVE

1. Check dash switch and blower motor connections.
2. If blower operates at high speed with switch in either "MED." or "SLOW" position, the speed control resistor at top of blower shroud is defective and should be replaced.

NOTE: Resistor is attached to the blower motor scroll by two screws. Only one-half of resistor winding may be defective; if so, replace the resistor assembly.

3. Check the blower motor.

VENTILATION

A single vent intake at front center of cab cowl (fig. 32) permits outside air to enter cab under dash panel. The vent is controlled by "VENT" control handle located at top center of dash panel. Pulling "VENT" handle rearward opens the vent. Vent closes when handle is pushed forward.

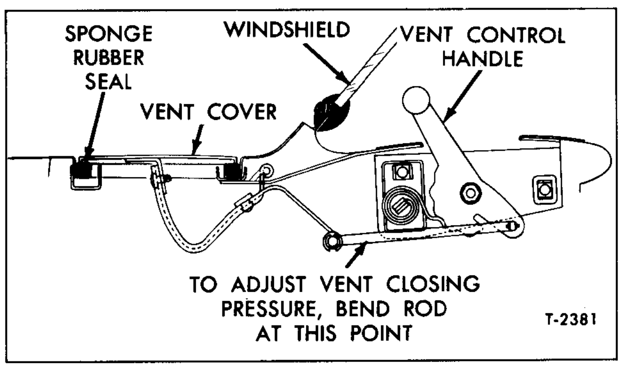


Figure 32—Cab Outside Air Vent

Figure 32 illustrates the vent control mechanism shown in closed position.

Sponge rubber seal under vent cover should be replaced if deteriorated or damaged. Before installing new seal, remove all the old seal and adhesive from seal channel.

If vent cover fails to close firmly against seal, the link rod under dash can be bent slightly as required to increase the closing pressure.

NOTE: Do not bend rod excessively as the control handle will fail to remain in closed detent position.

NOTE

For All Air Conditioning Information Refer to Separate "AIR CONDITIONING" sub-section at end of this section.

NOTE

Refer to "GENERAL MAINTENANCE" at beginning of this section for information on straightening, refinishing, and painting of cab which will apply.

STEEL TILT CAB

Maintenance information on windshield wipers, windshield and rear window glass replacement, and cab painting is explained in "GENERAL MAINTENANCE" section at beginning of this group. Refer to LUBRICATION (SEC. 0) for cab lubrication information. Contents of this section are listed in Index below:

CAB DESCRIPTION

The series 70 through 90 tilt cab is of all-steel welded construction (fig. 1). Cab fully surrounds engine and can be tilted 55 degrees to expose engine for servicing. The cab tilting mechanism is integral with cab front mountings and tilting is accomplished by means of a torsion bar extending across cab front hinge mountings. One end of torsion bar is anchored to cab, whereas opposite end is anchored to chassis. Cab is retained in lowered (operating) position by positive locking mechanism located at rear of cab.

Access for minor engine servicing, such as oil and engine coolant, is accomplished without tilting cab through access doors in panel at rear of passenger seat and at top of seat back riser. A concealed step is constructed in floor of each door opening. Also, a central island shifting area that is not disturbed with the cab tilted, is located between the seats. Island contains transmission shift lever and hand brake lever.

Two-piece windshield is retained in cab openings with a one-piece rubber seal expanded into position by a small rubber insert. No sealing compound or cement is used. Rear window glass and rear side glass is retained in same manner as windshield glass.

Doors are on swing-out type hinges with the upper hinge incorporating a spring-loaded door check for holding door open. Door is retained at the rear by a striker bolt on cab pillar. Outside handles are stationary-type screw retained to door and have a push button-type latch control.

Vent window in forward portion of door is of friction-type having a positive theft-resistant latch. Friction mechanism consists of a nylon bushing on lower pivot of vent which exerts frictional force against tension clamp mounted to door paneling.

Outside air enters cab through a vent directly in front of driver and through the outside air heating system. Air entry from outside of cab is made through a louvered, removable panel, located in front center of cab just above radiator grille opening. Air flows through plenum chamber between

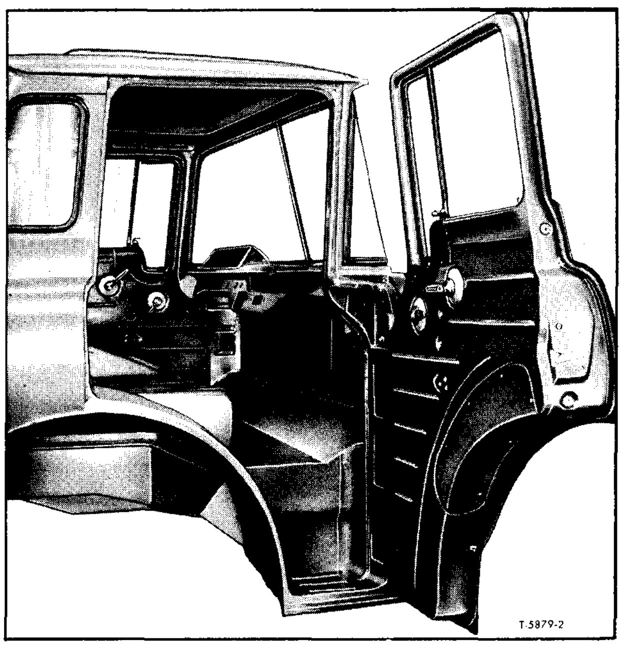


Figure 1—Tilt Cab Interior Construction

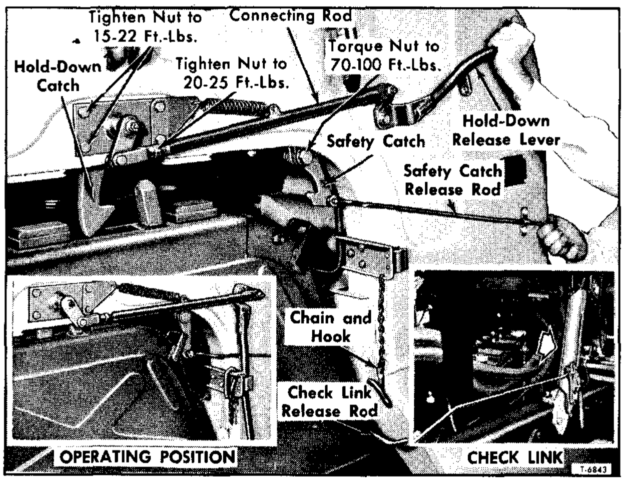


Figure 2—Releasing Cab Hold-Down Mechanism

outer and inner cab paneling and is dispersed to heater and vent outlet.

Cab is three-point mounted to chassis. Weight of cab at front is supported on cab right and left tilt hinges and a support bracket having rubber cushions, supports cab at rear center. Cab tilt hold-down mechanism locks cab firmly on cushions.

The underside of cab is completely insulated to deaden sound and prevent corrosion. A rubber weatherstrip around perimeter of door is used for sealing door to cab opening.

CAB TILTING INSTRUCTIONS

TO RAISE CAB (Fig. 2)

IMPORTANT: Before tilting cab forward, remove loose articles in cab; also place transmission shift lever in neutral and apply hand brake.

1. Close both doors of cab.
2. At right rear of cab remove safety chain hook.
3. While holding safety catch release rod to the right, pull hold-down release lever out and upward until hold-down catch becomes disengaged and rear of cab raises from mount (fig. 2). Tilt the cab completely forward until check link at right front mounting locks cab safely in full-tilt position.

IMPORTANT: Make sure check link is properly engaged with frame anchor pin.

TO LOWER CAB (Fig. 2)

IMPORTANT: Before lowering the cab to operating position, make sure transmission shift lever is in neutral position and that hand brake lever is in the applied position.

1. Release check link at right front mounting (see inset, fig. 2) by pulling rearward on link release rod, then pull cab back to operating position.
2. Safety catch at rear of cab will automatically become engaged. Pull downward on hold-down release lever and engage lower end of lever in lever spring catch, bracket-mounted to rear of cab.
3. Engage safety hook through matching holes in clip bracket and lug on lever by inserting the chain hook from underside.

NOTE: The raising and lowering effort of cab can be adjusted as desired by means of relocating torsion bar anchor lever at left frame bracket. If required, make adjustment as directed later under "Torsion Bar Tension Adjustment."

CAB MOUNTINGS

Cab is three-point mounted with two pivot-type mountings at front and twin cushion-type mountings at rear. Refer to figure 3 for typical views of mountings.

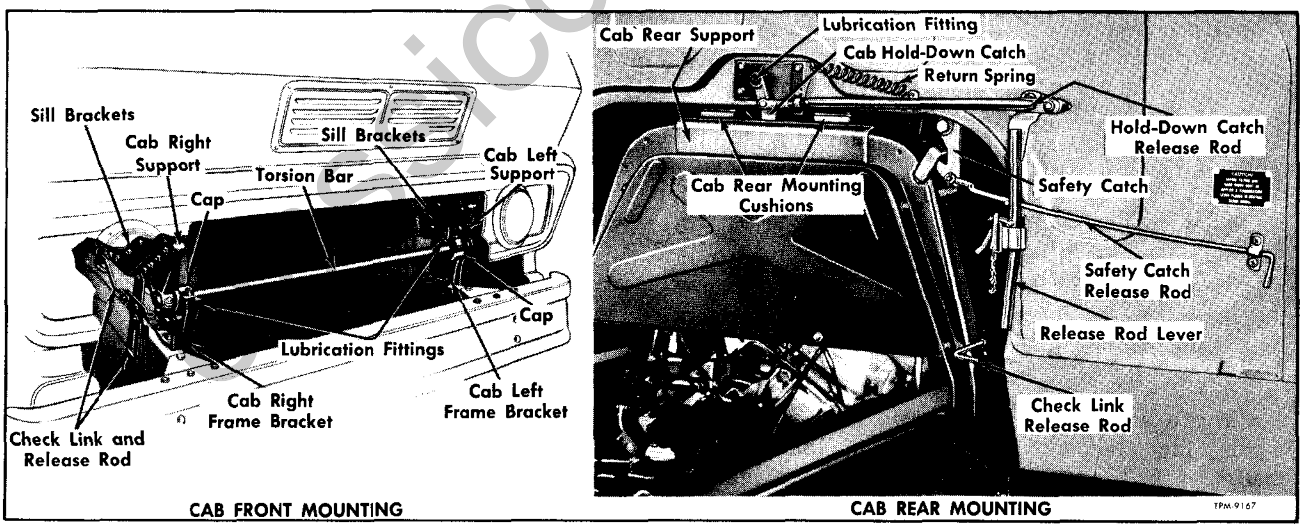


Figure 3—Cab Mountings

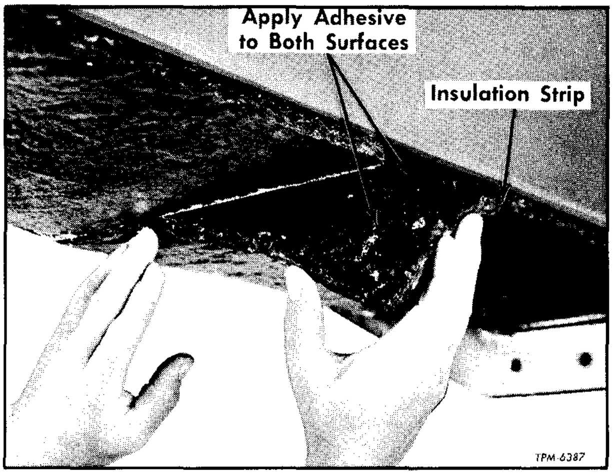


Figure 4—Applying Insulation

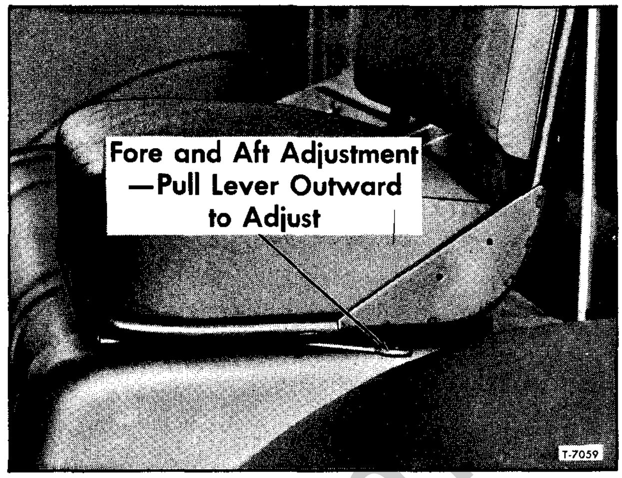


Figure 5—Driver's Seat Mounting and Adjustment

Interconnected with the cab front mountings is a torsion bar (fig. 3) which is under load when cab is in either the operating or full-tilted position. Right end of bar is anchored to cab bracket and left end is anchored by lever to frame bracket as shown in figure 3. Bar is unloaded when cab is tilted approximately 45 degrees, therefore, torsion bar assists operator in both the raising and lowering of cab.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD THE BOLTS WHICH ATTACH TORSION BAR RIGHT ANCHOR BRACKET TO CAB AND THE TORSION BAR LEFT ANCHOR LEVER TO FRAME BE LOOSENED OR REMOVED WHEN CAB IS IN OPERATING OR FULL TILT POSITIONS WHICH IS WHEN BAR IS LOADED. AN INJURY COULD RESULT WHEN ANCHOR BRACKET AND TORSION BAR IS ALLOWED TO RELEASE.

Attaching bolts can be removed safely when bar is unloaded, cab tilted part way (approx. 45 degrees). Normally it should never be necessary to remove bolts. Whenever torsion bar is inoperative, cab must be supported safely.

Attaching bolts at front pivot mountings should be checked at regular intervals for tightness. Loose mountings will allow shifting of cab and eventual failure of other items connecting cab to chassis. Front pivot mountings have fittings for lubrication purposes. Lubricate as directed under LUBRICATION (SEC. 0) of this manual.

Rear mounting has positive locking mechanism to retain cab in normal operating position in relation to chassis frame. The rear mounting also includes an additional safety catch. Tightness of cab hold-down lock can be adjusted by shortening or lengthening catch release rod. After adjusting rod, tighten end yoke lock nut. Cab hold-down catch shaft is equipped with a lubrication fitting.

A check link is provided near the right front mounting (see inset, fig. 2) which limits the distance cab can be tilted forward and automatically locks the cab in the full-tilt position. Check link must be released before cab can be returned to normal operating position.

INSULATION

Insulation, applied to cab understructure directly over engine, is highly resistant to abrasion and corrosion and is designed to give maximum sound deadening and insulation.

In the event a repair such as welding is required to that part of cab covered with insulation, it is first necessary to remove the insulation from that area. After completing repair, insulation sections can be cut to size and cemented over the repaired area (fig. 4). Be sure to clean area thoroughly before installing new section of insulation.

SEATS

SEAT ADJUSTMENT (Fig. 5)

Driver's seat is provided with "fore" and "aft" adjustment only. Pull out on lever at left side of seat to disengage seat position lock.

SEAT TRACK REPLACEMENT (Fig. 5)

1. Tilt cab forward, then remove four nuts and washers from studs which attach seat tracks to seat riser of cab.
2. Lower cab to operating position, then lift seat assembly from cab.
3. Remove four nuts which attach each track assembly to seat assembly and remove track.
4. Reverse the above procedure to install track assembly.

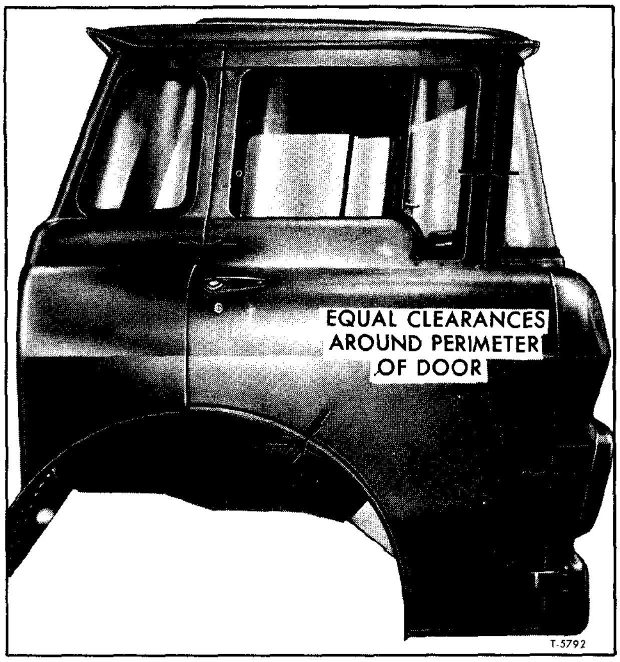


Figure 6—Door Clearances

DOORS

Component sub-assemblies of cab doors, such as window regulator, door lock, remote control, vent window, and door window can be replaced without necessity of removing door from cab. Doors can be removed, however, without prior removal of above components. Removal and installation of door window glass is described later in this section.

DOOR REPLACEMENT

REMOVAL

1. With the aid of an assistant to support weight of door, remove the screws which attach hinge straps to door. Access to one cap screw at door upper hinge is gained by removing plug from door inner panel.
2. Carefully remove door assembly from cab.

INSTALLATION

Attach door to hinge straps with six cap screws. Adjust door in cab opening as instructed later under "Door Adjustments."

DOOR ADJUSTMENTS

Doors can be adjusted for alignment or clearance in the cab door opening (fig. 6), and for proper latching. Door alignment adjustments are made at the striker bolt, and at door hinges. The door, when properly located in door opening, will have equal clearance around its perimeter.

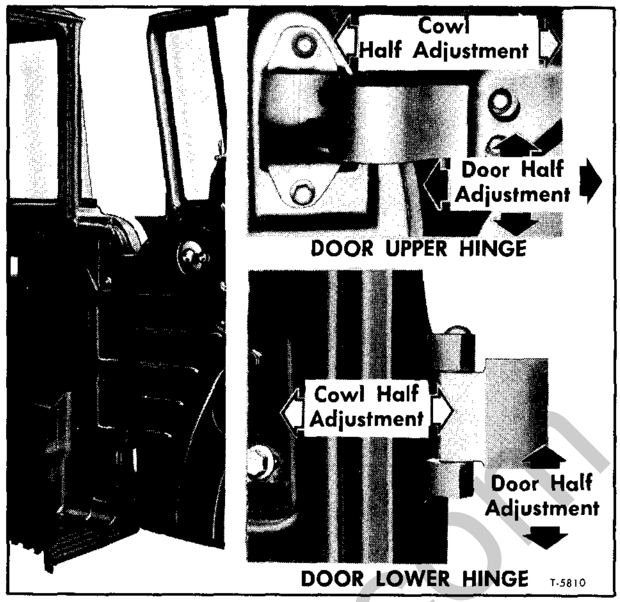


Figure 7—Door Hinges

If door has been replaced, adjustments should be made in sequence described in the following paragraphs:

REPOSITION DOOR "UP" OR "DOWN" (Fig. 7)

Door "up" and "down" adjustment in cab opening is provided by means of floating hinge cap screw tapping plates within door framing. Horizontal slotted cap screw holes in cab half of hinge assembly provide the "in" or "out" adjustment of door.

1. Remove striker bolt from cab pillar.
2. Loosen hinge-to-door cap screws slightly. Reposition door on hinges to provide equal clearance around perimeter of door in cab opening.

NOTE: Access to one cap screw at door upper hinge is gained after removing plug from door inner panel.

3. After satisfactory adjustment has been obtained, tighten hinge cap screws firmly. Open and close door to check operation. If necessary, repeat adjustment. Install hinge cap screw access plug in door inner paneling after making final adjustment.
4. Install striker bolt and adjust as directed later under "Striker Bolt Adjustment."

REPOSITION DOOR "FORE" OR "AFT" (Fig. 7)

Only the upper portion of door can be adjusted "fore" or "aft." This adjustment is made at the upper hinge. No means for this adjustment exists at the lower hinge.

1. Remove striker bolt from cab pillar.
2. Loosen upper hinge-to-door cap screws slightly. Access to one cap screw at door upper hinge is gained after removing plug from door inner panel.

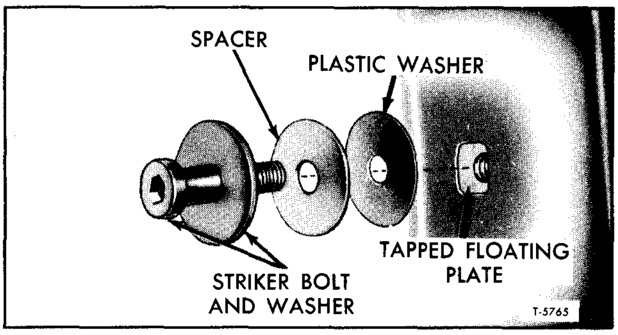


Figure 8—Door Striker Bolt and Washers

3. Lift upward or pull downward at rear of door to tilt upper portion of door "fore" or "aft" as desired.

4. Tighten hinge cap screws firmly after making adjustment. Open and close door to check operation. Repeat adjustment if necessary. Install cap screw access plug in door inner paneling.

5. Install striker bolt and adjust as directed later under "Striker Bolt Adjustment."

REPOSITION DOOR "IN" OR "OUT" (Fig. 7)

Horizontal cap screw slots exist in cab half of hinge assembly to permit this adjustment.

The outer surface of door, when properly installed, should be flush with adjacent surfaces of cab. If necessary, reposition door as follows:

1. Loosen slightly all cap screws which attach hinge half to cab pillar.

2. If door is to be brought outward from cab opening, apply pressure at door hinge area from inside cab. If door is to be moved inward, apply pressure on door outer panel at hinge area. Be careful not to damage door paneling by applying excessive pressure.

3. After adjustment has been made, tighten hinge cap screws firmly. Open and close door to check operation. Readjust if necessary.

NOTE: It may be necessary to reposition striker on pillar after making above adjustment. See "Striker Bolt Adjustment."

DOOR STRIKER

The door striker consists of a special bolt and washer assembly which is threaded into a tapped, floating cage plate located behind the cab lock pillar as shown in figure 8. The door is secured in closed position when the lock cam in door engages and snaps-over the striker bolt. Striker bolt can be replaced or adjusted as directed under applicable headings.

STRIKER BOLT REPLACEMENT (Fig. 8)

1. Mark position of striker bolt spacer or washer on door pillar using pencil or crayon.

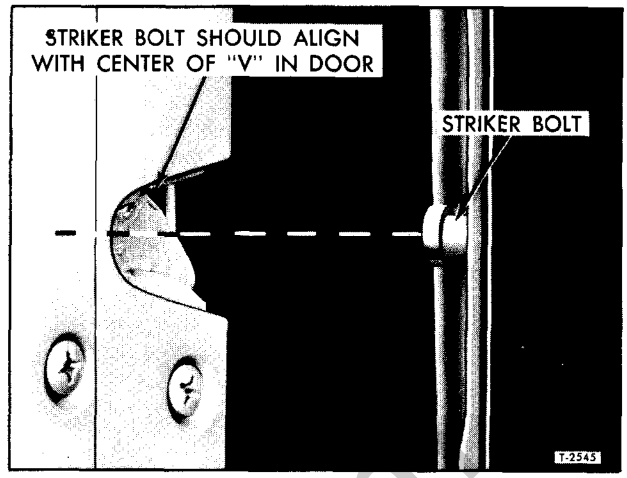


Figure 9—Sight Checking Striker Bolt Alignment

2. Insert a 5/16-inch hex wrench into head of striker bolt, then turn bolt counterclockwise from plate in cab pillar.

3. Reverse above procedure to install striker bolt. Make sure the thin plastic washer is positioned against the painted door opening pillar and center the bolt washer within marks on pillar.

4. If door has been removed and then installed or aligned in opening, the door should not be closed completely until a visual check is made to determine if lock cam in door will engage the striker bolt correctly. Center of striker bolt should be in direct alignment with "V" slot in door. See figure 9. If necessary, reposition striker bolt as directed below under "Striker Bolt Adjustment."

STRIKER BOLT ADJUSTMENT (Fig. 10)

Striker bolt on cab pillar is adjustable vertically and transversely after loosening the bolt with a 5/16-inch hex wrench. The bolt fore and aft adjustment is obtained by use of shim spacers located between the bolt washer and the cab pillar. Figure 8 illustrates location of bolt, washers, and spacer.

Striker Bolt Fore and Aft Adjustment

1. To check striker bolt for proper fore and aft adjustment, smear grease or paint to contact side of bolt as shown in figure 10.

2. Slowly close door until lock cam of door just contacts the side of striker bolt and makes an impression in the grease or paint.

3. Measure distance between head of bolt and the cam impression in grease. Distance should measure 1/8-inch as shown in right view of figure 10. This dimension is necessary to assure that the head of striker bolt will ride at center of nylon shoe which is located just in back of the lock cam.

To obtain this dimension, remove the striker bolt and install or remove shim spacers. Spacers

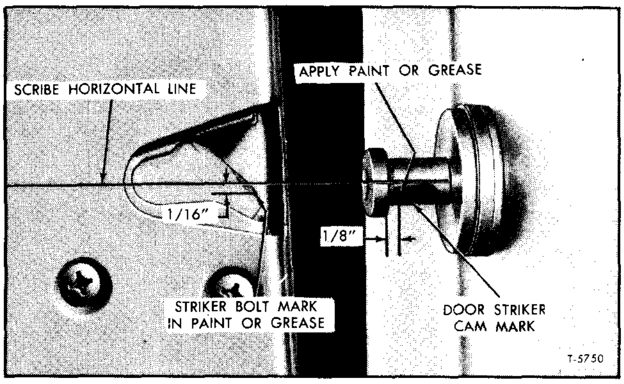


Figure 10—Striker Bolt Alignment

are available in two thicknesses: 5/64-inch and 5/32-inch. Make sure the thin plastic washer is located next to cab pillar.

After obtaining proper fore and aft adjustment, tighten bolt snug only at this time and then proceed with the "Striker Bolt Height Adjustment."

Striker Bolt Height Adjustment

This adjustment is important to assure that the right proportion of door's weight will rest on striker bolt when door is closed. If bolt is positioned too high on pillar, rapid wear will occur to the lock cam: if too low, an extra load will be placed on door hinges as well as pull door downward and out of alignment.

Generally the striker bolt height adjustment can be checked quite accurately by just sighting the center of "V" slot on door with the center of striker bolt as illustrated in figure 9. However, to make a more positive check, perform the following:

1. Mark a horizontal line through center of "V" slot and on door lock cam as shown in left view of figure 10.
2. Smear some grease or paint on contact edge of lock cam as shown in same view.
3. Slowly close door until cam barely contacts the striker bolt to leave an impression in grease. Open door and check contact mark on edge of cam. Mark should be located approximately 1/16-inch below the horizontal mark if properly aligned.
4. If necessary, raise or lower the loosened striker bolt up or down by tapping on the washer or spacer at base of striker bolt. DO NOT TAP ON HEAD OF BOLT.

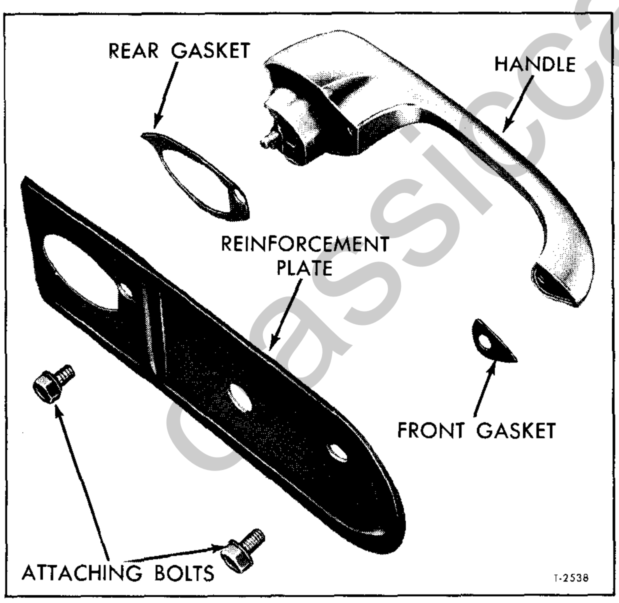


Figure 11—Door Handle Installation

Figure 12—Disengaging Handle Spring Retainer

Door Rear Edge "In" or "Out" Adjustment

This adjustment is for purpose of aligning the rear surface of door flush with adjacent surfaces of cab. If surfaces are not flush, proceed as follows:

1. Mark a horizontal line on cab pillar at top of striker bolt base washer or spacer.
2. Loosen striker bolt slightly, then tap against bolt base washer, to move bolt "in" or "out" as necessary to locate door surface flush with cab surface when door is closed. Before tightening the striker bolt make sure top bolt base washer is contacting the horizontal mark on cab pillar. Final tighten striker bolt.

DOOR OUTSIDE HANDLE REPLACEMENT

REMOVAL

1. Remove eight screws which attach access panel to lower portion of door. Remove access panel.

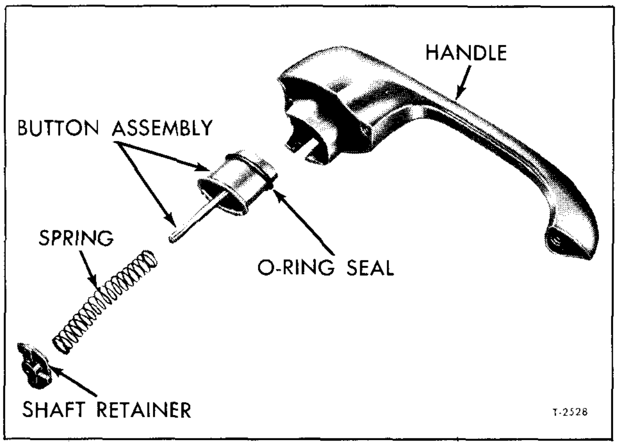


Figure 13—Door Handle Components

2. Roll door glass to top, then through access opening, using a 7/16" wrench, remove two bolts which attach door handle to door outer panel. Remove handle and handle gaskets (fig. 11).

NOTE: Reinforcement plate is spot-welded to inside of door outer panel.

3. Remove the button shaft retainer by first depressing, then rotating retainer as shown in figure 12. Remove shaft spring and button assembly with O-ring seal from handle (fig. 13).

INSTALLATION

1. Place button assembly with installed O-ring seal in handle.
2. Locate spring over button shaft, then install spring retainer (fig. 12).
3. Position door handle with gaskets to door outer panel, then through access opening at bottom of door, install two attaching bolts.
4. Install access panel to bottom of door.

DOOR LOCK CYLINDER REPLACEMENT

REMOVAL (Fig. 14)

1. Remove access panel at bottom of door.
2. Through access panel opening, pull lock cylinder retainer from beneath the lock cylinder grooves by grasping retainer lip with pliers.
3. Tilt lock assembly to permit cylinder lug to disengage from lock mechanism lever. Remove lock cylinder and gasket from door.

INSTALLATION (Fig. 14)

1. With gasket in position on lock cylinder, insert cylinder in door and engage lug over lock mechanism lever.
2. While holding cylinder, insert legs of retainer into grooves of lock cylinder body. Be certain legs of retainer are fully engaged. It may be necessary to drive retainer into final engagement with a light hammer.
3. Insert key and check operation of lock. If lock operates freely, install lower access panel to door.

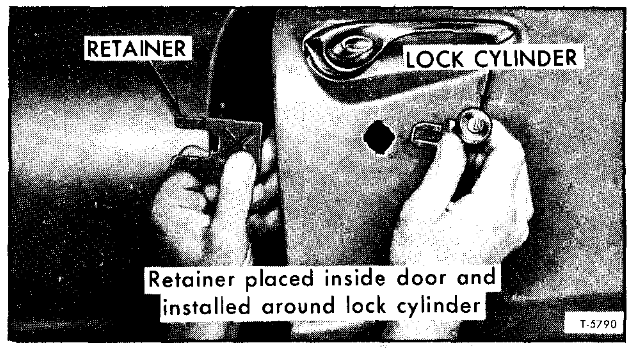


Figure 14—Door Lock Cylinder Replacement

DOOR INSIDE HANDLE REPLACEMENT

Window regulator crank handle and door lock handle are retained on shafts by lock springs. If

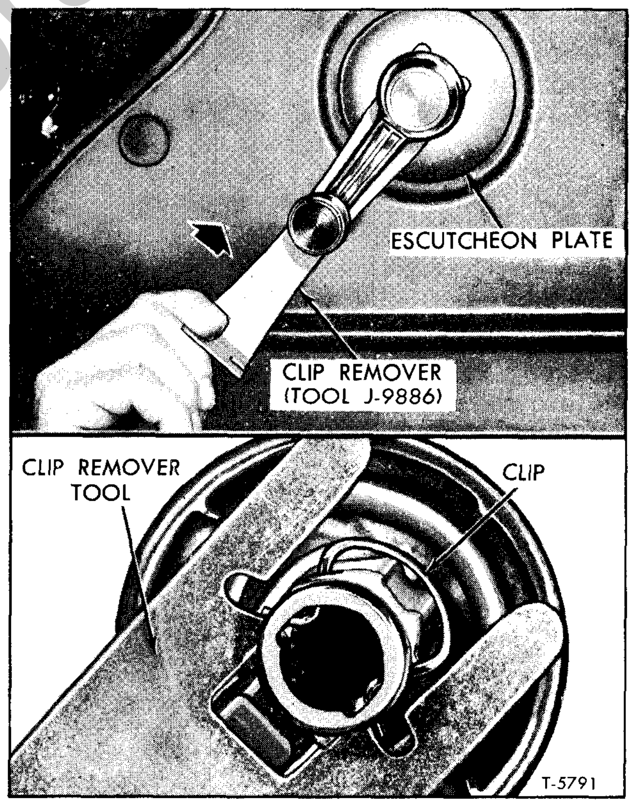
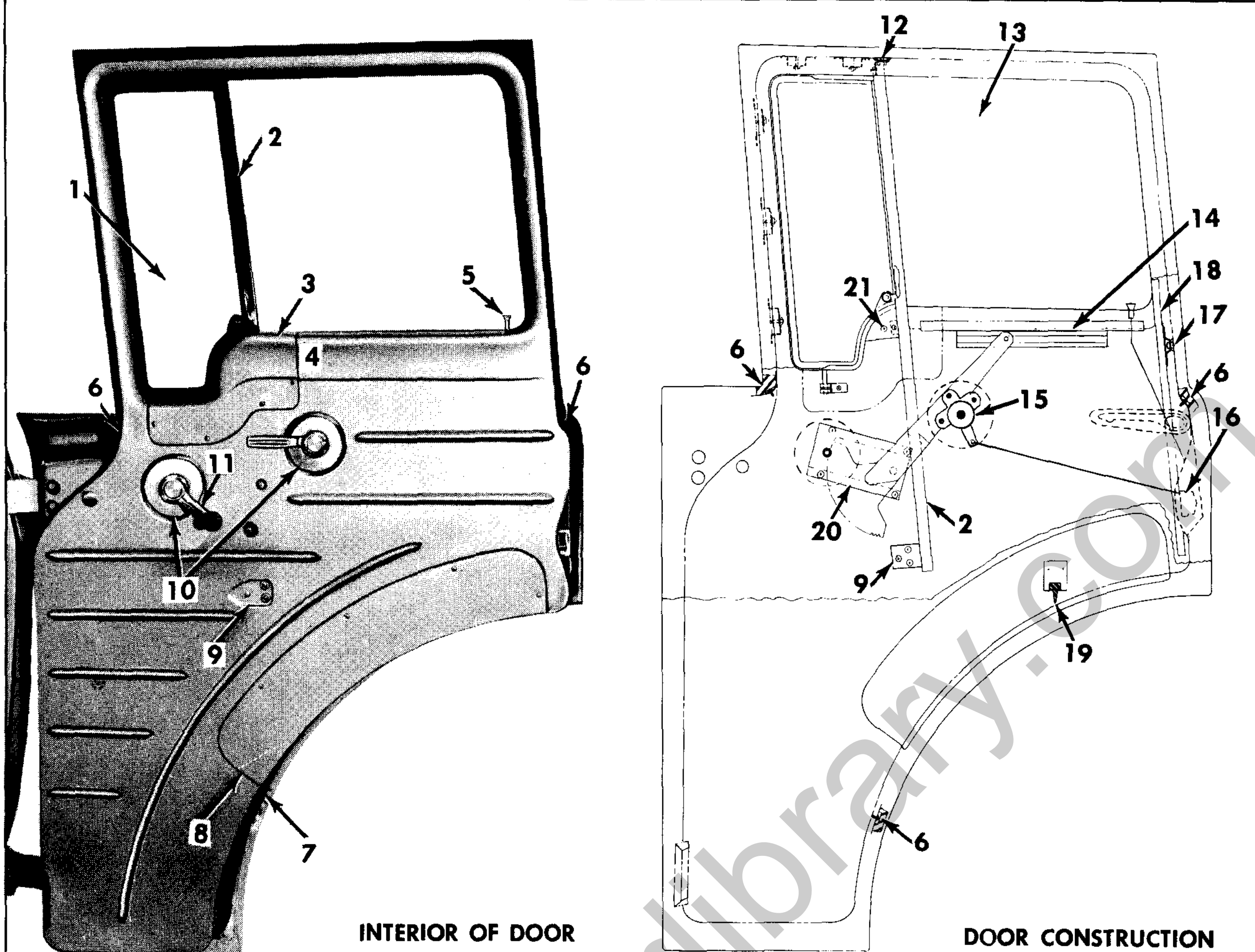


Figure 15—Disengaging Door Inside Handle



1 Vent Window Glass
2 Division Channel
3 Access Panel
4 Remote Control Handle
5 Inside Lock Knob
6 Weatherstrip Seal Clip and Screw
7 Weatherstrip Seal
8 Access Panel
9 Division Channel Lower Attaching Screws
10 Escutcheon Plates
11 Regulator Handle
12 Division Channel Upper Attaching Screws
13 Door Window
14 Sash Channel
15 Door Lock Remote Control Assembly
16 Door Lock Mechanism
17 Run Channel Retainer Screw
18 Run Channel Retainer
19 Door Window Stop Bumper
20 Window Regulator Assy.
21 Division Channel Center Attaching Screw

T-5789-1

Figure 16—Door Construction

removing door lock inside handle, the handle position should be marked in relation to door panel to assure that handle is installed later at the same operating angle.

REMOVAL (Fig. 15)

1. Insert tool (J-9886) between handle flange and escutcheon plate.
2. Force lock spring from grooves in base of handle. DO NOT LOSE SPRING. Remove handle and escutcheon plate.

NOTE: The lower view in figure 15 shows how the tool engages the clip at underside of handle when removing. Clip may be installed in opposite direction than shown.

INSTALLATION

1. Insert lock spring in handle grooves.
2. Place the escutcheon plate on handle spindle.
3. If installing door lock handle, make sure handle is in position previously marked on door inner panel. To install either handle, force handle with installed lock spring over spindle until lock spring becomes fully engaged.

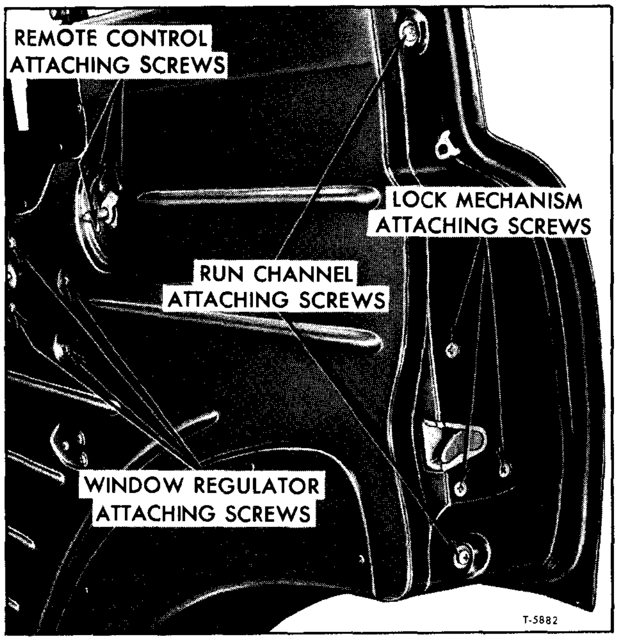


Figure 17—Door Lock Attaching Screws

DOOR LOCK AND REMOTE CONTROL MECHANISM REPLACEMENT

NOTE: Figure 16 illustrates the position of the lock and remote control mechanism components.

REMOVAL (Fig. 17)

1. Remove the door inside lock knob which is threaded on lock rod.
2. Remove the lower access panel from door inner panel as directed previously.
3. Raise window and then remove the door inside handle as directed previously.
4. Remove three screws which attach remote control to door inner panel. Lower control to door access opening, then disengage fastener at pull-rod. Separate rod and remove control from door.
5. Remove the lock cylinder assembly from outer side of door as directed previously.
6. At rear edge of door, remove two run channel retainer screws to provide clearance for removal of lock mechanism.
7. At rear edge of door, remove three special locking-type screws which attach lock mechanism to door frame. Lower the lock and attached two rods out through access opening in door.
8. Separate rods from lock mechanism by disengaging fasteners.

INSTALLATION (Figs. 16 and 17)

Install lock mechanism with rods and remote control in reverse of the "Removal" procedures.

IMPORTANT: Make sure to use the three

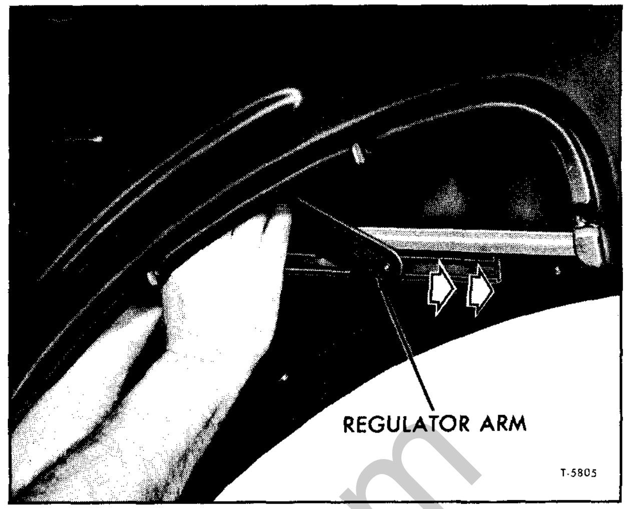


Figure 18—Removing Regulator Arm from Track

special locking-type screws which attach lock mechanism to door frame. Check operation of door lock and remote control mechanism after installation. As required, remote control unit may be shifted slightly on door inner panel to obtain satisfactory lock operation.

DOOR WINDOW REGULATOR REPLACEMENT

REMOVAL

1. Remove access panel from lower portion of door.
2. Lower window and remove window regulator handle and escutcheon plate.

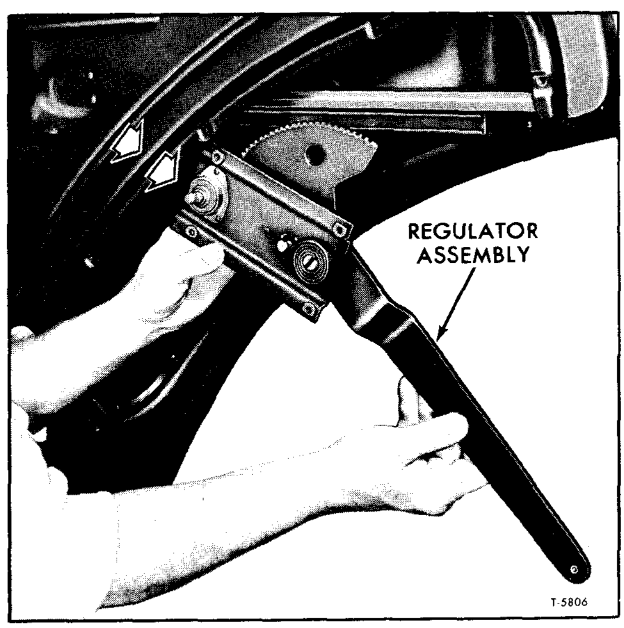


Figure 19—Lowering Regulator from Door

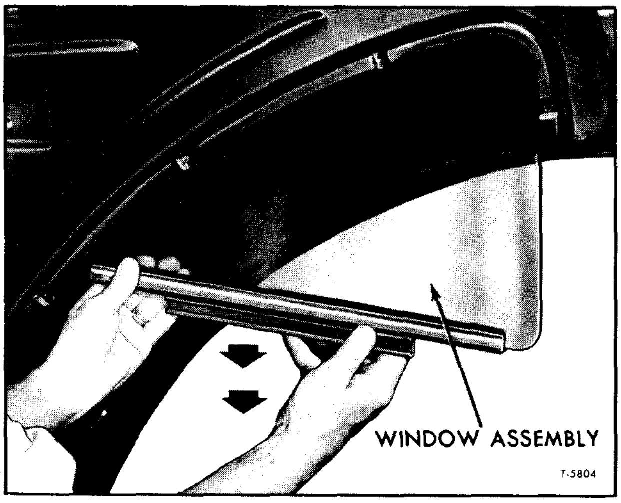


Figure 20—Removing Door Window Glass

3. While holding regulator assembly through opening in door, remove four screws (figs. 16 and 17) which attach regulator assembly to door inner panel.

4. Guide regulator arm to remove roller from window channel track (fig. 18). Carefully lower regulator assembly from door (fig. 19).

INSTALLATION

Install door window regulator in reverse order of "Removal" procedures. Before installing access door, operate window regulator to be sure roller is not binding in window channel track. If binding occurs, bend window regulator arm slightly until roller turns freely in channel. Also, check division and run channels for alignment.

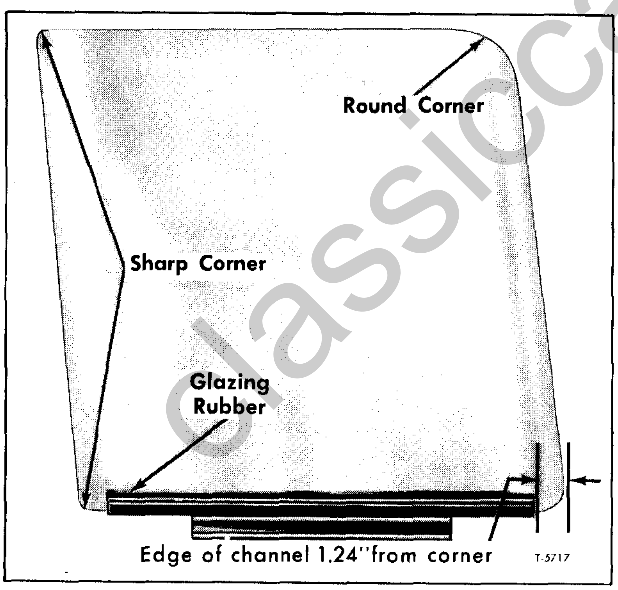


Figure 21—Door Glass Assembly (Right Side Shown)

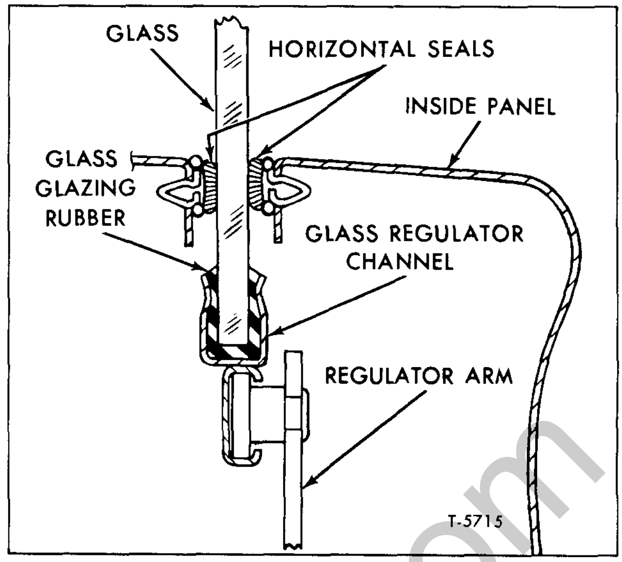


Figure 22—Cross Section of Window Regulator Channel

DOOR WINDOW GLASS REPLACEMENT

REMOVAL

1. Remove access panel from door inner panel below vent window.
2. Unlatch vent window and swing outward.
3. Remove five screws which attach access trim panel to door just below vent window.
4. Remove frame to door screw and frame to divisional channel screw (fig. 16).
5. Remove three division channel lower attaching screws (fig. 16).
6. Remove division channel screws at top of door (fig. 16).
7. Remove two screws at edge of door which attach run channel to door (figs. 16 and 17).
8. Lower window and remove window regulator assembly as described previously (figs. 18 and 19).
9. Tilt and lower glass assembly through lower access opening (fig. 20).

INSTALLATION

1. Squirt gasoline along glass filler on both sides of glass to soften seal. Remove glass from channel when filler is sufficiently soft.
2. Thoroughly clean inside of glass channel by removing all rust and old glazing rubber filler.
3. Cut new piece of glazing rubber filler to length of glass regulator channel.
4. Position glazing rubber filler (soapstone side away from glass) on bottom edge of glass 1.24-inch from lower corner as shown in figure 21.
5. Carefully position edge of glass regulator channel 1.24-inch from lower right corner (fig. 21) and then press channel over glass and glazing

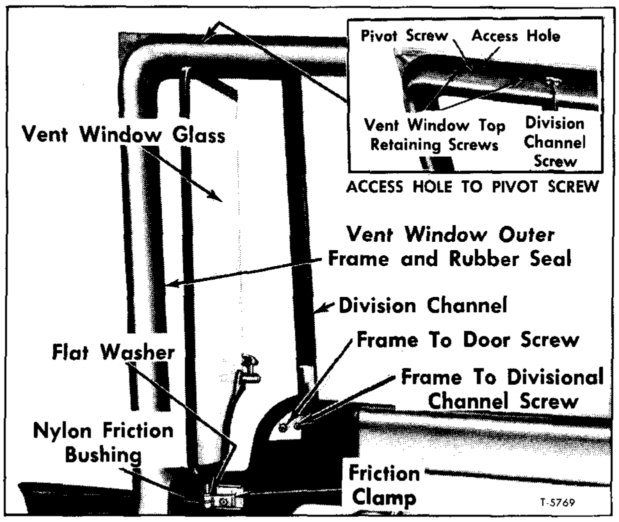


Figure 23—Door Vent Window Installed

rubber filler. Lightly tap channel with rubber hammer to firmly seat channel over glass and filler.

6. Install assembled window into door in reverse order of "Removal" procedures.

NOTE: When inserting glass assembly into door run channels, be careful not scratch or place undue stress on glass. After installation, raise and lower window to check for binding. If binding occurs, adjust appropriate run channels by loosening applicable channel attaching screws.

DOOR WINDOW GLASS HORIZONTAL SEALS REPLACEMENT

1. Remove access panel from bottom of door. This will remove window stop attached to access panel and allow top of window to be lowered to a point below horizontal weatherstrips.
2. Using a flat-blade screwdriver, pry weatherstrips from door (fig. 22).
3. Install weatherstrips to door, making sure retaining clips are fully engaged.
4. Raise window, then install access panel to bottom of door.

DOOR WINDOW RUN CHANNEL REPLACEMENT

1. Remove door window as explained previously under "Door Window Glass Replacement."
2. Remove applicable screws which attach either division channel or run channel to door framing (fig. 16) and lower channel(s) through access opening at bottom of door.
3. Install channel(s) in reverse order of removal procedures.

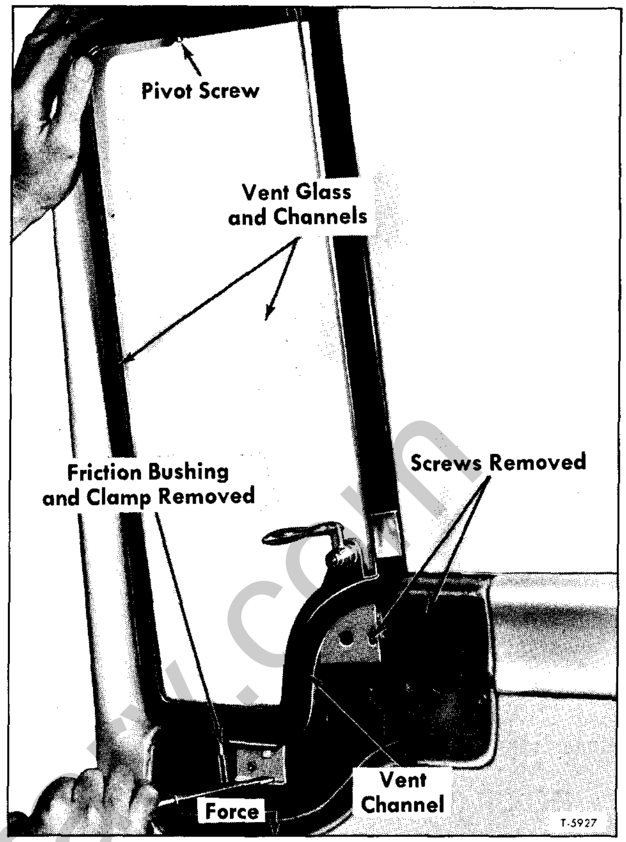


Figure 24—Removing Vent Window

4. Install and adjust window glass as explained previously under "Door Window Glass Replacement."

DOOR VENT WINDOW TENSION ADJUSTMENT

Cab vent windows are of friction type having a positive theft-resistant latch. Friction mechanism consists of a bushing attached at lower end of vent shaft which rotates in a stationary friction clamp.

If friction mechanism is adjusted too tight, it will be difficult to open or close vent. Too loose an adjustment will result in a fluttering vent or one having a tendency to close with wind pressure.

If necessary to change vent friction, perform procedures as follows:

1. Remove access trim panel attached to door just below vent window with five screws. Figure 23 shows access opening to friction components.
2. Using screwdriver, turn clamp screw (fig. 23) to obtain two to four pounds torque while moving vent window from a ten-degree open position to a full-open position. Use either a push or pull-type spring scale positioned at rear edge of glass.

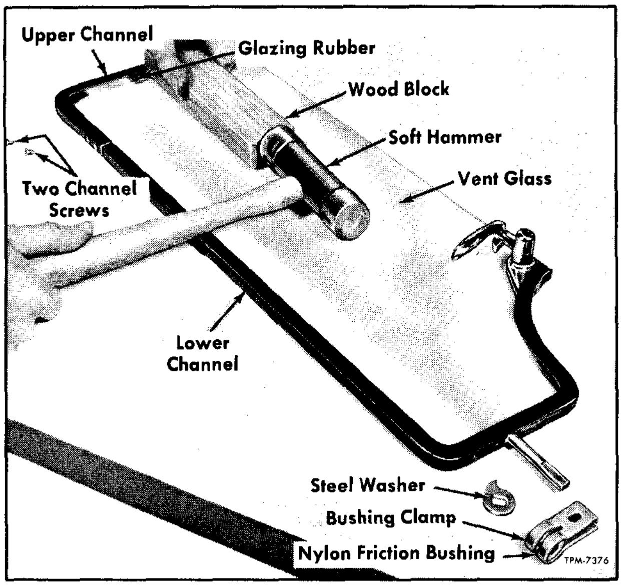


Figure 25—Vent Window Disassembled

3. After obtaining proper tension, install access trim panel.

DOOR VENT GLASS REPLACEMENT

REMOVAL

1. Remove small access panel from inner side of door below vent window.
2. At bottom of vent glass (fig. 23), place hand to catch vent friction components, then remove screw from friction clamp. Slide clamp, friction bushing, and flat steel washer from vent shaft.
3. At top of door through small access opening (see inset, fig. 23), turn vent upper pivot screw from vent frame.

NOTE: Screw need not be removed completely, just enough to become disengaged from vent glass channel.

4. Remove three screws which attach division channel to vent channel just below vent latch. Using a screwdriver, pry down on vent channel as shown in figure 24, which will cause upper part of channel to become disengaged from pivot screw. Rotate glass channel lower pivot shaft up out of vent channel.
5. Remove two screws which attach glass upper channel to glass lower channel (fig. 25).
6. Apply gasoline on vent glazing rubber to soften old rubber. When rubber softens sufficiently, separate upper and lower glass channels, then remove old glass.

INSTALLATION

1. Thoroughly clean inside of glass channels to remove old glazing rubber, rust, or other foreign matter.

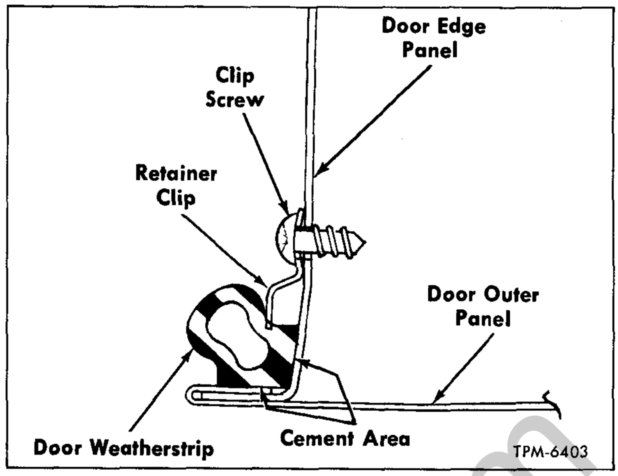


Figure 26—Door Weatherstrip Installed

2. Position new glazing rubber (soapstone side away from glass) around edge of glass. Press glass with glazing rubber into lower channel, then press upper channel over top of glass. Make sure channels are firmly seated, then install two small screws which attach channels together (fig. 25).
3. If necessary, trim glazing rubber at ends of channels and along sides of channel each side of glass. As required, seal cracks at latch bracket.
4. Insert pivot stud of vent lower channel into hole of vent frame as shown in figure 24. Through small access hole at top of door, install vent upper pivot screw. Install three screws which attach bracket of vent channel to glass division channel just below vent latch.
5. Install special flat washer, nylon friction bushing, and friction clamp on vent lower channel pivot shaft, positioned as shown in figure 23.

NOTE: Make sure that tab on special flat washer is positioned properly to act as a stop of vent when it is in full open position. Attach friction clamp to vent lower frame with screw. Tighten screw to obtain two to four pounds torque while moving vent window from a ten-degree to a full-open position. Use either a push or pull type spring scale positioned at rear edge of glass.

6. Install access panel to inner side of door.

DOOR WEATHERSTRIP REPLACEMENT

1. Remove screw-retained clips from weatherstrip around perimeter of door. Figure 26 shows view of weatherstrip installed at retainer.
2. Pull weatherstrip from door, then scrape any rubber or adhesive material which may have become bonded to door surface.

3. Apply coat of weatherstrip adhesive to seal and seal surfaces of door as directed by manufacturer of adhesive. Directions for application are usually found on adhesive container.

4. Position seal around perimeter of door, making sure corners of seal engage respective corners of door.

5. Install screw-retained clips (fig. 26) to door and weatherstrip. Tighten clip screws firmly but be careful not to tear weatherstrip.

CAB VENTILATION AND HEATING

VENTILATION

A single grilled intake at front center of cab (fig. 26) permits outside air to enter plenum chamber located between the cab outer and inner panels. From the plenum chamber, outside air can be directed into cab interior through opening at front of driver and through opening at front of passenger. When heater is used, the outside air enters heating system through the right side opening.

The outlet located ahead of driver is opened and closed manually by control knob on dash. The control knob pushed inward closes outlet door and pulling out on knob opens outlet door. A spring-loaded door prop retains door snug in either the fully opened or closed positions. A rubber seal around perimeter of outlet door provides positive sealing of outlet. Seal, which is glued to door, can be readily replaced if necessary.

CONTROL ADJUSTMENT (DRIVER"S SIDE)

NOTE: Refer to inset of figure 27.

When control knob on dash is pushed completely in, the air outlet door should close snug to outlet opening.

If door is not seated completely with control knob in this position, loosen screw at control conduit clamp above door which will allow compression spring within door telescopic prop to force door tight to opening. Retighten clamp screw after making adjustment.

HEATING

The heater is of the water valve temperature control type (fig. 28) and is serviced in same manner as "Air-Flow Heater" described previously under "Conventional Model Cabs."

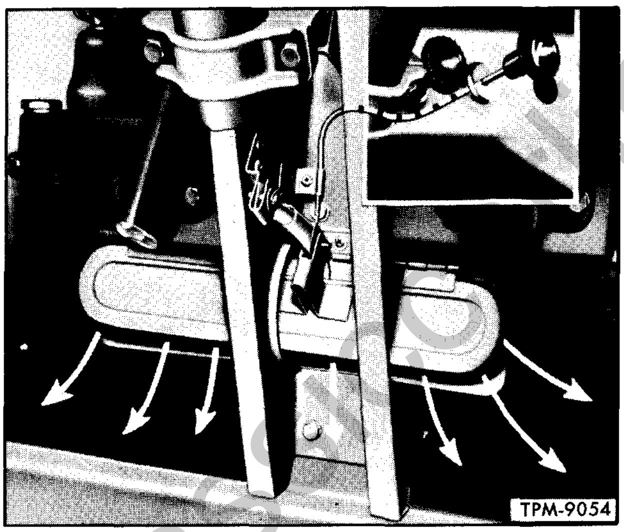


Figure 27—Outside Air Intake

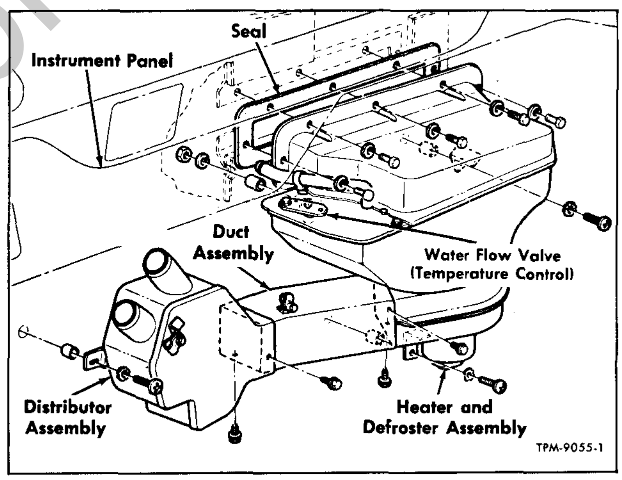


Figure 28—Heater Installation

CAB REPLACEMENT

Necessary equipment for efficient and safe replacement of cab consists of a chain hoist (1-ton minimum capacity), a sling having padded hangers, and two or more support blocks to rest cab on when it is removed from chassis.

NOTE: A wood 4 x 4, 7½ feet long positioned through cab door openings with a hoist chain attached securely to each end can be used. However, means of protecting top of cab from chain must be provided. Also, be sure to provide padding at points where beam contacts cab openings and carefully position beam to assure proper cab support.

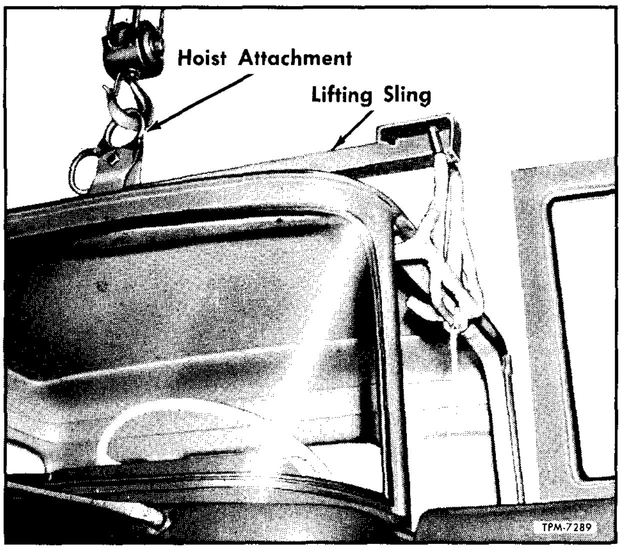


Figure 29—Lifting Sling Attached to Cab

CAB REMOVAL

1. Disconnect battery ground strap.
2. On vehicles with air brakes, exhaust air supply from air tank at drain fitting. Remove bumper (with attached air tank, if used).
3. Open heater temperature control on dash to full open position, and drain radiator. Disconnect heater hoses at cab connections.
4. Disconnect accelerator linkage and steering flexible coupling, marking for later alignment. Disconnect brake lines and clutch line.
5. Disconnect speedometer cable and all electric connectors that junction cab with the chassis. Remove cab-to-chassis ground straps.

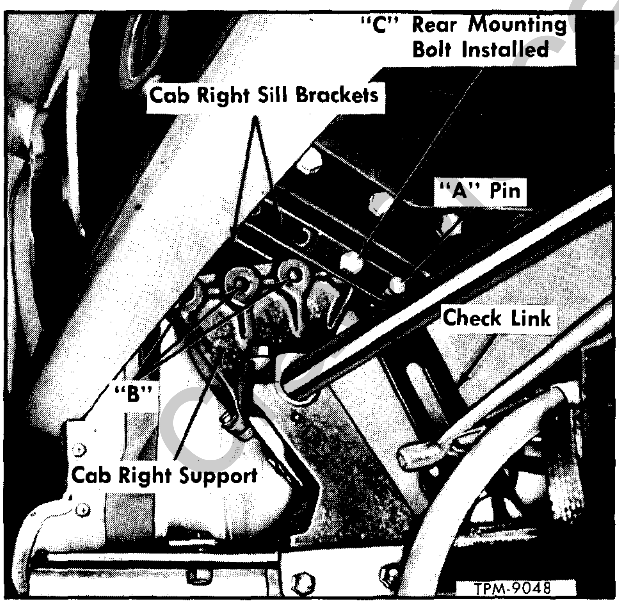


Figure 30—Mounting at Cab Rear Support

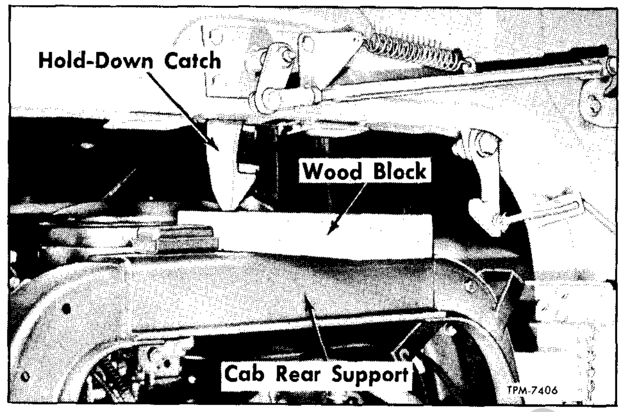


Figure 31—Rear Hold-Down Catch on Wood Block

NOTE: REMOVE OR SECURE ALL LOOSE ITEMS IN CAB BEFORE TILTING. PLACE SHIFT LEVER IN NEUTRAL AND THE HAND BRAKE IN FULL-APPLIED POSITION.

6. Attach a suitable padded lifting sling (fig. 29) to cab with doors partly open (lifting cab with doors closed will disturb door alignment later).
7. Using aid of assistant and hoist, tilt cab approximately 45° to the unloaded position of cab mounting torsion bar (refer to preceding caution) and suspend safely there. While cab is in this position, insert a pry bar in between cab right support and cab sill. Remove three forward bolts, lock washers and nuts from cab right support to sill brackets (B, fig. 30). Use pry bar to assist in removing bolts. Disconnect check link at right side of cab.
8. Place a short piece of wood 2" x 4" over catch hole in cab rear support (fig. 31), then with aid of assistant, lower cab until catch at bottom of cab rests on block. This will prevent engagement of cab hold-down catch. Remove two retaining bolts from torsion bar at cab left support and remove support cap. Raise cab slightly, and remove rear mounting bolt (C, fig. 30) attaching right support to sill brackets.
9. Raise cab slightly to clear cab lift mechanism, then forward and up to clear shift control panel. Figure 32 shows cab and chassis disconnect points.
10. Lower cab onto suitable blocks, then remove chainfall and lifting sling.

NOTE: Left support can be removed from cab, if desired.

CAB INSTALLATION

1. Install lifting sling and chainfall to cab with doors slightly open (fig. 29).

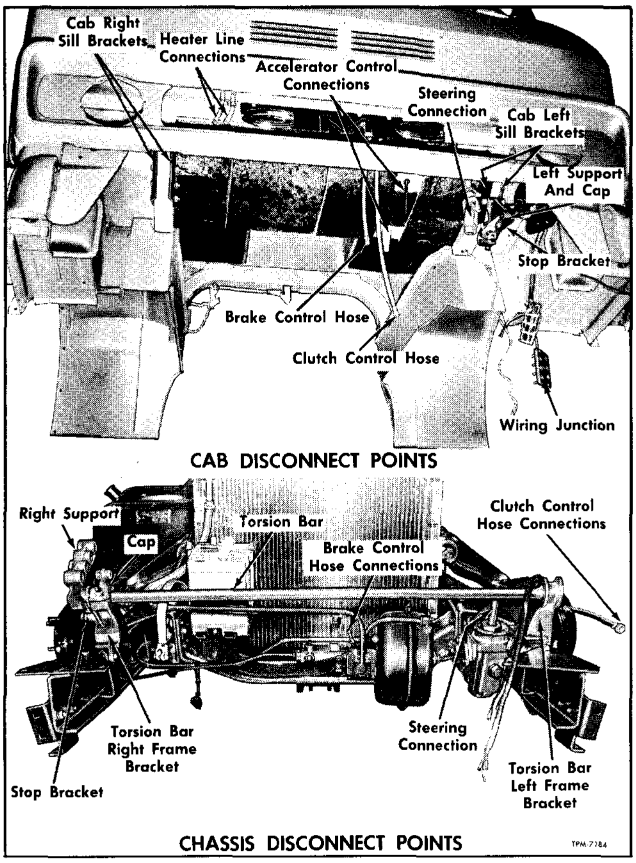


Figure 32—Cab and Chassis Disconnect Points (Typical)

2. Raise cab and install support (if previously removed) loosely to cab left sill brackets.

NOTE: Cab tilt torsion bar, check link, and right cab to sill support should be in position on chassis as shown in lower view of figure 32.

3. Raise cab over chassis and lower into position, forward slightly to clear shift control panel, then back and down until steering gear coupling can be engaged using marks made previously for proper alignment.

4. Finish lowering cab until left support rests on torsion bar. Install support cap with two bolts, torque bolts to 50-60 foot-pounds.

5. Install check link retaining clevis pin with cotter pin (A, fig. 30). Install bolt (C, fig. 30) into rear hole of cab right sill brackets and support.

6. Insert a pry bar in between cab right support and cab sill.

7. With two assistants, one holding pry bar and the other helping to tilt cab forward (approximately 45 degrees), install the three remaining bolts, lock washers, and nuts (B, fig. 30) in the right cab support and sill brackets. Use pry bar to align bolt holes. Torque bolt nuts to 40-50 foot-pounds.

8. Tighten steering coupling clamp bolt to 40-50 foot-pounds torque. Connect speedometer cable

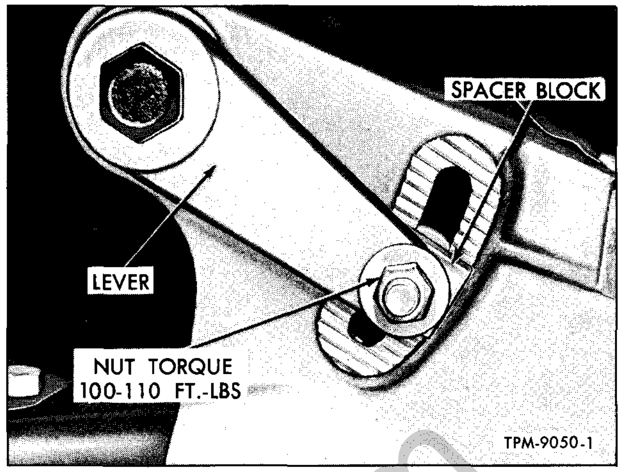


Figure 33—Torsion Bar Tension Adjustment Lever Installed

and all electric connectors that junction with the cab-to-chassis.

9. Connect accelerator linkage and adjust as outlined under ENGINE FUEL SYSTEM (SEC. 6M). Connect all ground straps.

10. Connect brake lines and hoses. Bleed the brakes as outlined under "HYDRAULIC BRAKES" (SEC. 5A) if equipped with hydraulic brakes.

11. Connect clutch flexible line and bleed as outlined under "CLUTCH CONTROLS" (SEC. 7D).

12. Connect heater hoses and fill radiator.

13. Install bumper to front of frame. If vehicle is equipped with air brakes, connect air lines.

14. Check cab tilting and lock action.

TILT CAB TORSION BAR REPLACEMENT

A chain hoist and a lifting sling are required to properly replace cab torsion bar as the weight of cab must be removed from bar. Also, the aid of one or more assistants is recommended.

REMOVAL

Instructions below pertain to cab replacement procedures when cab is tilted (approximately 45 degrees) and suspended safely with weight of cab removed from chassis. A chain from hoist hook, down over rear center of cab and attached to cab rear hold-down catch will assist in maintaining cab safely at a 45-degree angle.

IMPORTANT: Protect top of cab from damage by hoist equipment.

1. Secure hoist sling at rear of door openings.

2. Remove weight of cab from chassis.

3. Remove two retaining bolts from mounting cap at torsion bar right frame bracket and from support cap left support.

4. Remove bolt, nut, and washers which attach torsion bar anchor lever to cab mounting left

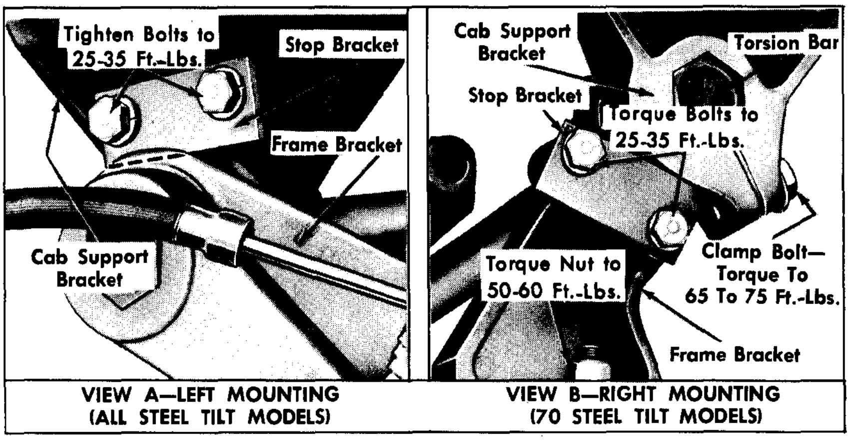


Figure 34—Cab Torsion Bar Stop Brackets Installed

frame bracket. Remove arm from bar and bracket.

5. Loosen cap screw which clamps cab right mounting bracket to right end of torsion bar.

6. Slide torsion bar from cab right frame bracket, then slide bar in opposite direction from cab left support.

CAUTION: DO NOT hammer on end of bar.

INSTALLATION

1. Before replacement of torsion bar, inspect frame brackets (castings) and cab supports (castings) for cracks. DO NOT WELD OR BRAZE BRACKETS. If cracked, replace.

2. Prelubricate left frame bracket opening and right frame bracket. Slide hex end of torsion bar into left frame bracket, then insert opposite end into cab right support.

3. Install torsion bar anchor lever over end of bar and into frame bracket.

NOTE: Lever should be located on bar so that opposite end of anchor lever is located near center of serrations on cab bracket (fig. 33).

4. Install cab stop brackets (if previously removed) to torsion bar cab and frame brackets as shown in figure 34. Torque attaching bolts to 35 to 50 foot-pounds. Make sure stop brackets are installed as shown.

5. Install torsion bar right frame bracket cap and cab left support cap with two bolts and washers. Torque bolts to 50-60 foot-pounds.

6. Tighten bolt which clamps cab right mounting bracket to end of torsion bar (fig. 34) to 65-75 foot-pounds on series 70 or 100-110 foot-pounds on series 90 tilt cab models.

7. Lubricate all cab tilt lubrication fittings with lubricant specified in LUBRICATION (SEC. 0).

8. Raise and lower cab to check operation. If cab rises too fast from operating position or if considerable effort is required to raise cab, make torsion bar tension adjustment as directed later.

TORSION BAR TENSION ADJUSTMENT

1. Tilt cab forward to an angle whereby the torsional load is removed from torsion bar. Usually the bar will become unloaded when cab is tilted 45 to 50 degrees. This unloaded angle position may vary slightly on different vehicles.

IMPORTANT: Before continuing, check tightness of screw which clamps cab right mounting bracket to torsion bar. Tighten screw firmly ONLY when torsion bar is unloaded - cab tilted part way. If screw is loose, cab bracket may fracture when torsion bar is loaded.

2. SAFELY support cab at angle at which torsion bar becomes unloaded. An overhead hoist is recommended for supporting cab in this position as it will allow cab to tilt slightly fore or aft to facilitate alignment of torsion bar anchor lever to cab frame bracket.

3. Loosen nut on bolt which attaches the anchor lever and serrated spacer block to the cab frame bracket (fig. 33). Loosen nut only enough for spacer to clear serrations.

4. By tilting cab slightly fore and aft, the small serrated spacer block can be relocated to new related serrations on cab frame bracket as desired.

5. Tighten anchor bolt nut to 100-110 ft.-lbs.

6. Check cab tilting action. If necessary, reposition anchor point of torsion bar anchor lever as directed above.

NOTE: If adjustment is such that cab rises rapidly to full-tilt position, damage to cab check link could occur and also upon lowering of the cab to operating position, considerable effort may be required.

IMPORTANT: Final check tightness of anchor lever bolt nut.

ALUMINUM TILT CAB

(INCLUDES HEATING SYSTEM)

CAB CONSTRUCTION

The Aluminum Tilt 90 Series cab represents many modern engineering features designed to provide excellent driver comfort and safety (fig. 1). The cab is offered in three different BBC dimensions; standard cab is 54 inches, optional sleeper cabs are 74 and 86 inches. Refer to "GENERAL CAB MAINTENANCE" (SEC. 1A) for information concerning cab identification.

Cab is hinge-mounted at front to allow cab to be tilted 80 degrees forward for access to engine, controls, and cab understructure. Tilting is accomplished through use of a hand-operated hydraulic pump and lifting cylinder. A positive pin-type locking device is employed to retain cab in selected tilt position. Rear cab mount latches release hydraulically when tilt pump is operated in "UP" position.

Cab framing and paneling is of aluminum construction. Engine housing is composed of left and right hand stamped panels with a center connecting panel with offset. Formed sheet aluminum outer panels are sealed and riveted to major cab frame members.

Cab front upper panel is a formed aluminum stamping incorporating openings for heater inlet, radiator grill, and engine service doors. The access doors are hinge mounted with magnetic catches. The grill is a cross-hatched assembly of extruded aluminum strips surrounded by a bright metal moulding.

The roof, cab back, and sides are completely lined with rigid foam material. Over this is a layer of tufflex insulation covered with embossed black vinyl. Non-reflective finished materials are used throughout for interior of cab.

The floor is insulated and covered with rubber matting or optional black nylon carpeting. Carpeting is laminated to 1/2" resin impregnated tufflex with a polyethylene pigmented skin. Floor covering extends from dash to back of cab or sleeper compartment front panel.

The center console houses instruments, controls, heater, and air conditioning components (if equipped). Quick release fasteners retain access covers to console and allow easy access to wiring, instruments, and heater components.

The tinted windshield is of the two-piece type, retained in cab opening by means of a rubber weatherstrip with insert. The door and sleeper compartment ventilators are retained in cab and door openings in same manner as windshield. The rear window(s) is retained with a one-piece weatherstrip without insert.

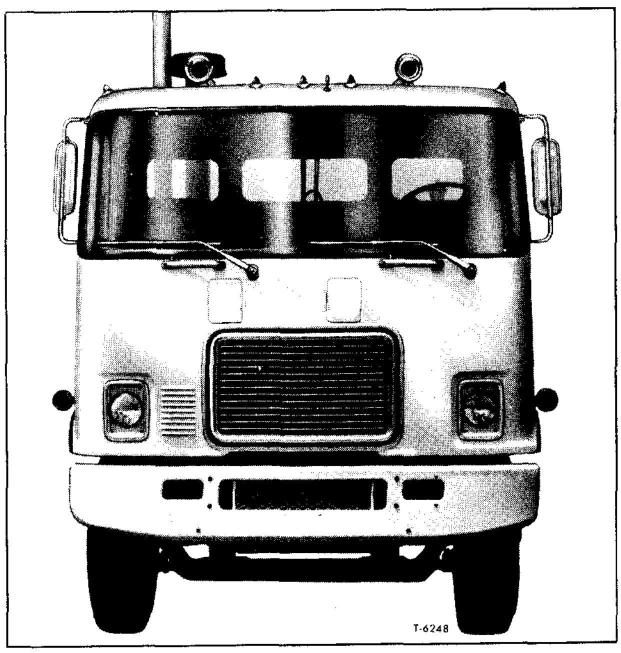


Figure 1—Aluminum Tilt Cab (90)

Extruded aluminum door frames surround perimeter of cab opening. Frames serve as upright structural members for rigid side support and assure proper door fit. Each entrance door is of double-wall construction and is attached to front of cab opening by a piano-type continuous hinge. Lower front section of each door has a cut-out section for a safety window or fresh-air ventilator. Manually operated door windows are provided with an electric power window available as optional equipment in right hand door only. Door vent window is of the friction-hinge type with a positive theft-resistant latch.

CAB TILTING MECHANISM

CAB TILTING INSTRUCTIONS

Cab tilting is accomplished by a manually operated hydraulic pump with oil reservoir in conjunction with one double-acting 2-inch diameter hydraulic cylinder. Cylinder and pump are mounted on outside of right frame rail. See Figures 2 and 3.

A valve control handle on the pump directs the flow of hydraulic fluid to the cylinder to cause cab to raise or lower.

The cab hold-down catches are also hydraulically operated and will automatically release when pump is operated with lever in "UP" position (fig. 4). An additional mechanically operated safety catch is also provided as part of the hold-down system.

Stamped on the top of the pump control valve are the letters "DN" and "UP". When the cab is in normal driving position, place lever in "UP" position. When pump is operated, cab will tilt forward. When the cab is tilted forward, place lever in "DN" position. When pump is operated, cab will lower to normal driving position.

RAISING CAB (Figs. 2, 3, and 4)

IMPORTANT: Before raising cab, remove or secure loose articles in cab, place transmission gearshift lever(s) in Neutral, and apply parking brake. Fasten driver's seat belt to clip. Make certain cab doors are closed tight.

1. Place valve lever in "UP" position.
2. Place pump handle in pump socket.

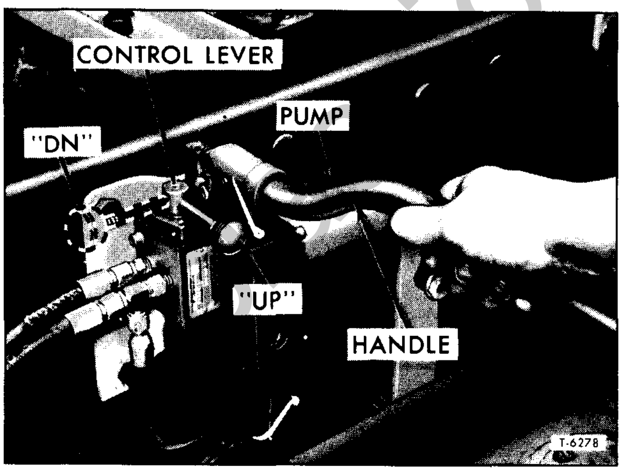


Figure 2—Cab Tilting Hydraulic Pump (Typical)

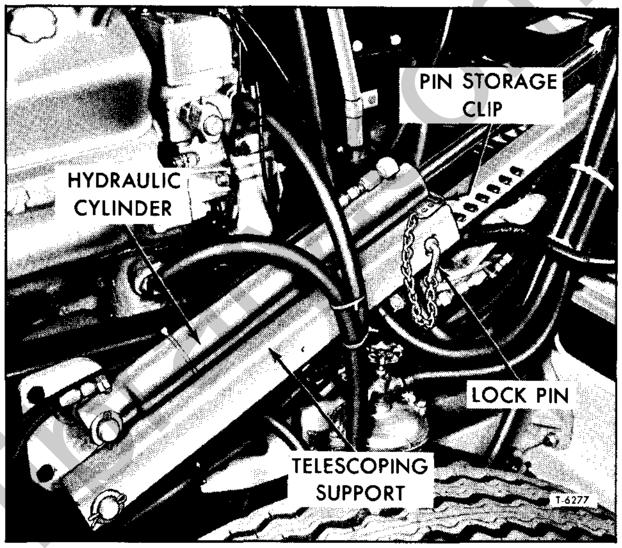


Figure 3—Tilt Cylinder and Linkage

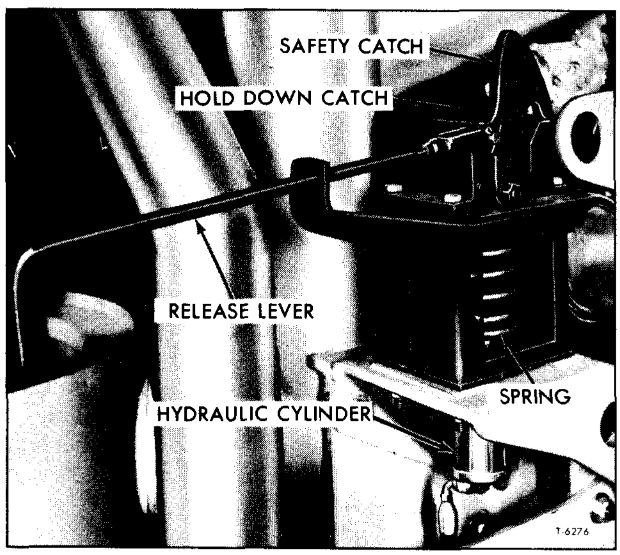


Figure 4—Cab Rear Mounting and Catch (Typical)

3. Pull mechanically operated safety catch handle out and hold until cab is free.

4. Lift cab by operating pump handle up and down.

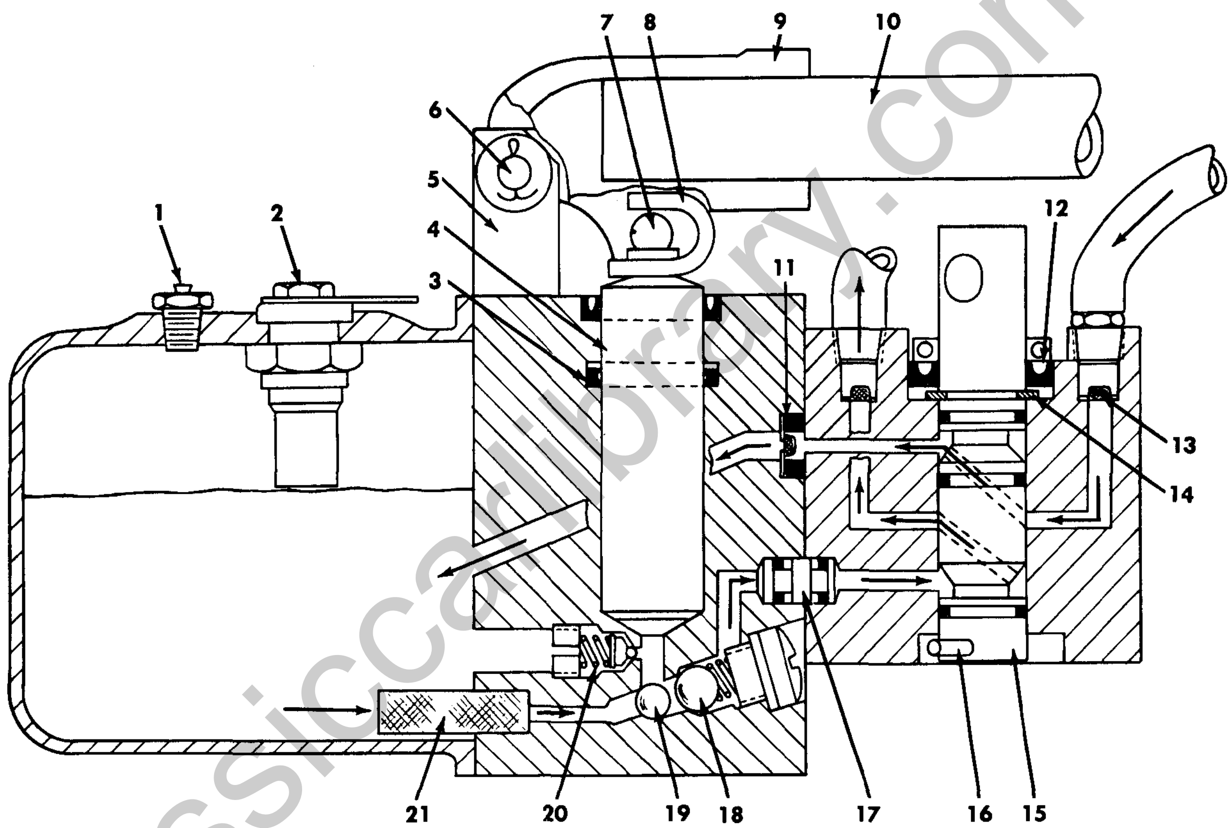
NOTE: When the cab is raised to the point where the weight of cab is greater forward of hinges than to the rear, the cab will fall forward by gravitational pull at a controlled rate.

Operator may further limit the rate of free fall by opening and closing the pump valve. This is done by moving control lever between "UP" and "DN" positions until cab has reached desired angle of tilt.

5. When desired tilt angle is reached, place safety pin in locking slots of tilt lever mechanism. As the result of the unique design of the tilt lever mechanism, the cab can be secured in any position from full tilt to full down.

CAUTION

LOCK PIN MUST BE INSERTED IN SLIDE CHANNEL WHENEVER CAB IS IN A RAISED POSITION. DO NOT RAISE OR LOWER CAB WITH PIN IN SLIDE CHANNEL.



1 Vent Plug
2 Fill Plug and Stand Pipe
3 Quad Ring With Back-Up Washer
4 Pump Piston
5 Beam Post
6 Clevis Pin - Beam
7 Pin
8 Clip - Piston Head
9 Beam
10 Handle
11 Fixed Orifice, Screen and Seal Ring
12 Oil Seal
13 Screens and Retaining Ring (Both Ports)
14 Snap Ring
15 Valve Spool
16 Roll Pin (Valve Control Stop)
17 Connector (Valve-to-Pump With O-Ring and Back-Up Washers)
18 Outlet Check Ball
19 Suction Check Ball
20 Relief Valve
21 Suction Screen

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Figure 5—Schematic of Hydraulic Pump Assembly (Typical)

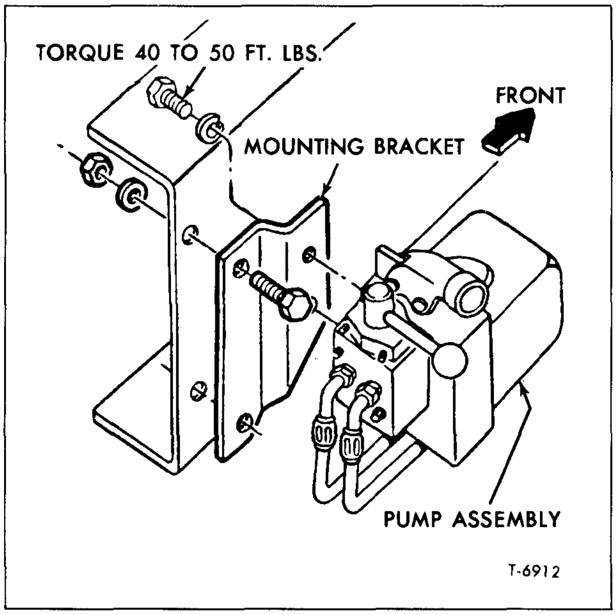


Figure 6—Hydraulic Pump Installation

LOWERING CAB (Figs. 2, 3, and 4)

1. Place gearshift lever(s) in Neutral and apply parking brake.
2. Place valve lever in "DN" position.
3. Place pump handle in pump socket.
4. Remove safety pin from locking slots in tilt lever mechanism. It may be necessary to operate pump slightly to relieve weight from pin before pulling it out.
5. Lower cab by operating pump handle up and down.

NOTE: When cab passes over-center so that weight of cab is greater to rear of pivot hinges than to front, the cab will fall at a controlled rate due to gravitational pull. Operator may further limit the rate of free fall by opening and closing the pump valve. This is done by moving control lever between "DN" and "UP" positions until cab has reached full-down position. The hold-down catches operate automatically, and when cab is in full-down position, hold-down catches and safety catch will lock. After cab is in full-down position, visually inspect each catch to be sure they are fully locked.

HYDRAULIC PUMP AND TILT CYLINDER

The cab tilting hydraulic pump is of the closed-reservoir type. Pump is equipped with a pressure relief valve to prevent hydraulic pressure from exceeding designed pump strength. A standpipe is inserted down into reservoir to assure ample air space is provided above hydraulic oil. Since the system is of the closed reservoir type, air space above oil is necessary to prevent cavitation when oil is removed from reservoir when tilting cab.

NOTE: Fill pump reservoir only through the fill plug and standpipe opening, not through relief vent plug opening, when cab is in "Down" position. This is necessary to prevent over-filling of hydraulic system which could result in erratic pumping action and oil spray through reservoir relief valve when cab is lowered.

PUMP OPERATION

NOTE: Key numbers refer to figure 5.

Hydraulic oil is drawn from reservoir through suction screen (21) and inlet check valve (19) due to upward movement of pump piston (4) as pump handle (10) and beam (9) are raised. Oil is pulled into pump cylinder until handle reaches end of upward travel.

When the handle is lowered, oil pressure closes suction check ball (19) and opens outlet check ball (18). Due to downward movement of piston, oil enters passage above outlet ball and is directed into valve spool cavity. The valve spool (15), shown in position for raising cab, diverts high pressure oil through passages and port screen leading to left hydraulic line as illustrated on figure 5. Hydraulic oil returning from tilt cylinder enters pump through right hand hose, passes through the upper portion of valve spool (15), into a fixed restriction orifice (11), and is returned to the reservoir.

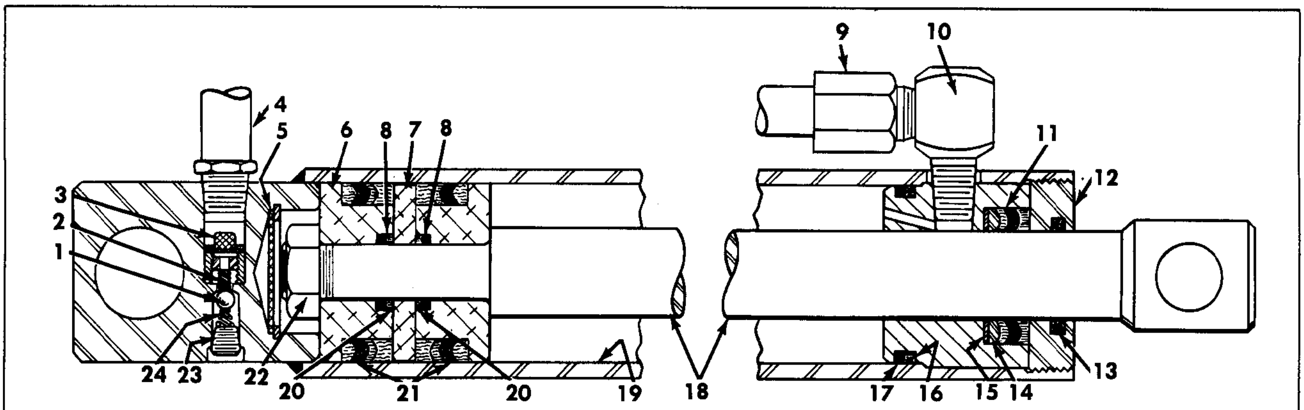
The fixed restriction orifice (11) is designed to limit the maximum rate of fall when cab weight passes "over center" during normal cab tilting or lowering. This fixed orifice is protected by a screen to prevent dirt from clogging passage. Also, externally adjustable stops are provided which contact roll pin (16) on valve spool (15). As required, these stops may be externally adjusted to further limit the rate of cab fall.

If operator continues to actuate handle when cab is fully tilted or if prop pin was not removed from lock position and control lever is in "UP" position, extreme hydraulic pressures can be generated which will open a pre-set relief valve (20). The relief valve is calibrated to allow sufficient pressure to tilt cab under all normal conditions, yet provide a moderate safety factor. When oil pressure beneath pump piston exceeds relief valve setting, valve will bypass oil directly to pump reservoir.

Quad rings and seals are used throughout pump to eliminate leaks due to oil pressure. Screens are used in oil passages to protect pump from external dirt that could enter through hydraulic lines or reservoir filler opening.

PUMP REPLACEMENT (Fig. 6)

1. Remove hydraulic hoses from control



1 Valve Ball
2 Spring
3 Strainer Screen
4 Fluid Hose
5 Screen
6 Piston
7 Piston Spacer
8 O-ring
9 Velocity Fuse
10 Elbow
11 Packing Set
12 Gland Nut
13 Wiper
14 Adapter
15 Wave Washer
16 Back-up Washer
17 O-ring
18 Piston Rod
19 Cylinder Assembly
20 Back-up Washers
21 Packing Set
22 Piston Rod Nut
23 Plug
24 Ball Spring

T-6918

Figure 7—Schematic of Tilt Cylinder and Velocity Fuses

valve body. Seal hose connections to prevent dripping of oil and entry of dirt.

2. Remove frame-to-pump bracket-bolts and remove pump from chassis.

3. Remove bracket-to-pump bolts from rear of pump body.

4. Reverse removal procedure to install pump assembly. Torque mounting bolts to 40-50 foot-pounds. Tighten hydraulic hose connections firmly after bleeding system as described later.

TILT CYLINDER OPERATION (Fig. 7)

Hydraulic oil from pump passes through high pressure hoses to the two rear cab mounting hydraulic latches and the tilt cylinder. The tilt cylinder is mounted on right side of vehicle between frame and cab.

The tilt cylinder assembly is composed of a high tensile strength cylinder, a chromium finished rod and piston, and two velocity safety fuses. The velocity fuses are of the same basic construction and are designed to prevent the cab from free-falling in the event a hydraulic hose or fitting breaks. One velocity fuse is located in the base end of the cylinder (push port); the other is mounted externally at the rod end of the cylinder (pull port).

The design of the velocity fuse is such that oil from the valve comes through the hose and immediately has to pass through the screen (3). This filters out any dirt that may be caught in the hose when the hoses are assembled to the system. The oil then passes through a hollow set screw and check ball (1) into the cylinder. In the reverse direction, oil passes around check ball (1) and through the hollow set screw and screen (3) and back to the pump through the hose. During the pumping cycle, it is impossible to generate enough oil to lock these fuses. Check ball (1) is held off the seat due to the pressure of spring (2) which is set by the hollow set screw.

All of these valves are factory set on an air-manometer to insure that they are all exactly alike. When the cab reaches the center of gravity and reaches the control fall portion of the cycle, a back pressure is created due to the oil trying to get back to the reservoir through the fixed orifice and valve spool. The valve spool, due to the adjustable stops, creates a back pressure all the way through the hose and back to the velocity fuse at the tilt cylinder. This back pressure plus the calibrated spring setting at the velocity fuse, will hold the check ball off its seat. If, for any reason such as a hose breaking, the back pressure developed at the pump will be lost and increased oil flow from cylinder will immediately drive the check ball onto its seat, thereby stopping oil flow from cylinder. In order to unlock check valve (lift velocity fuse ball from its seat), the broken hose or other damage must be repaired, then the pump control valve spool is placed in its alternate position and the pump handle actuated. This usually requires several strokes of the pump handle. Return pump control valve handle to original position and cylinder should operate normally.

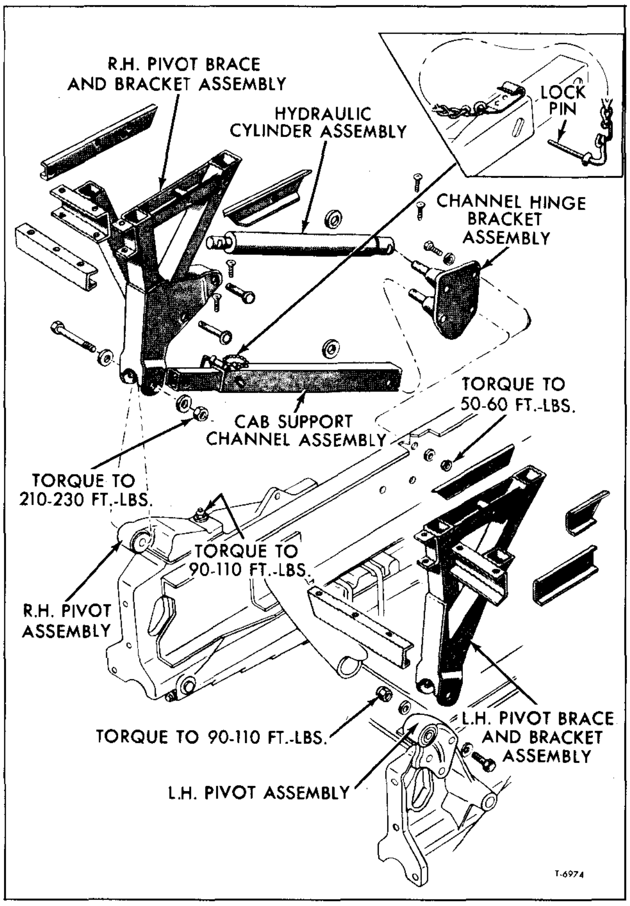


Figure 8—Front Mounting and Cylinder Installation

The setting of the velocity fuses are such that they will not actuate unless there is a serious break or leak in the system. The operator is able to adjust the valve spool with the adjustable stop and further there is the fixed orifice between the valve and the pump. The velocity fuse is set slightly higher than the fixed orifice rate. This means that regardless of what the operator does, he will not be able to set the velocity fuses if the system is operating properly. If the velocity fuses trigger and the hydraulic tilt system seizes, it indicates the cab is falling faster than the pump fixed orifice setting or a leak exists at some point in the hydraulic hoses or fittings. Repairs to system must be made to prevent fuses from triggering.

NOTE: NEVER attempt to repair individual parts of velocity fuses. They are factory calibrated and must be replaced as an assembly. If velocity fuses are defective, return complete tilt cylinder to factory for repairs.

During the controlled fall portion of the tilt cycle, a suction is created on one side of the tilt cylinder piston. This suction is sufficient to cause oil to be drawn directly into back side of the cylinder. The cylinder remains full of hydraulic oil at all times.

IMPORTANT: Replenish the hydraulic tilt system only with oil meeting MIL-H-5606B specification to ensure that oil maintains light viscosity to provide controlled back pressures through a wide temperature range. This is necessary to assure correct operation of velocity safety fuses and proper back-fill of cylinder during controlled fall portion of tilt cycle.

TILT CYLINDER REPLACEMENT (Figs. 7 and 8)

1. Lower cab. Remove hoses from both ends of tilt cylinder and seal connections.
2. Remove heater inlet duct from cab front panel.
3. Remove cotter pins and washers from both ends of cylinder. Remove cylinder from vehicle.
4. Prop channel assembly may be removed in same manner as tilt cylinder.
5. Reverse removal procedure to install tilt cylinder and prop channel assembly.
6. Tighten hydraulic hose connections firmly after bleeding system as directed later. Tighten bracket-to-frame bolts at base end of cylinder to 50-60 foot-pounds torque.

CAB LOCK ASSEMBLY REPLACEMENT
(Refer to Fig. 9)

1. Tilt cab and insert lock pin (fig. 8).
2. Remove hydraulic line from cylinder. Seal hose connection to prevent dripping of oil and entry of dirt.
3. Remove four bolts from frame bracket and cab lock assembly. Then remove lower cab support and cab lock assembly from frame bracket.

NOTE: On right hand assembly, if necessary, remove safety hook bracket bolts and hold down rod support bracket bolts. Then remove hold down rod, safety hook return spring, safety hook bracket and hold down rod support bracket.

4. Inspect and replace parts as necessary.

NOTE: To replace O-ring seals and hold down spring, follow procedure outlined later.

5. Reverse removal procedure for installing cab latch assembly noting torque specifications as shown in figure 9.
6. After installing hydraulic line to cylinder bleed the system as described later.

O-RING REPLACEMENT ON CAB
LOCK ASSEMBLY (Fig. 10)

NOTE: On some models it may not be necessary to remove cab lock assembly to replace O-rings.

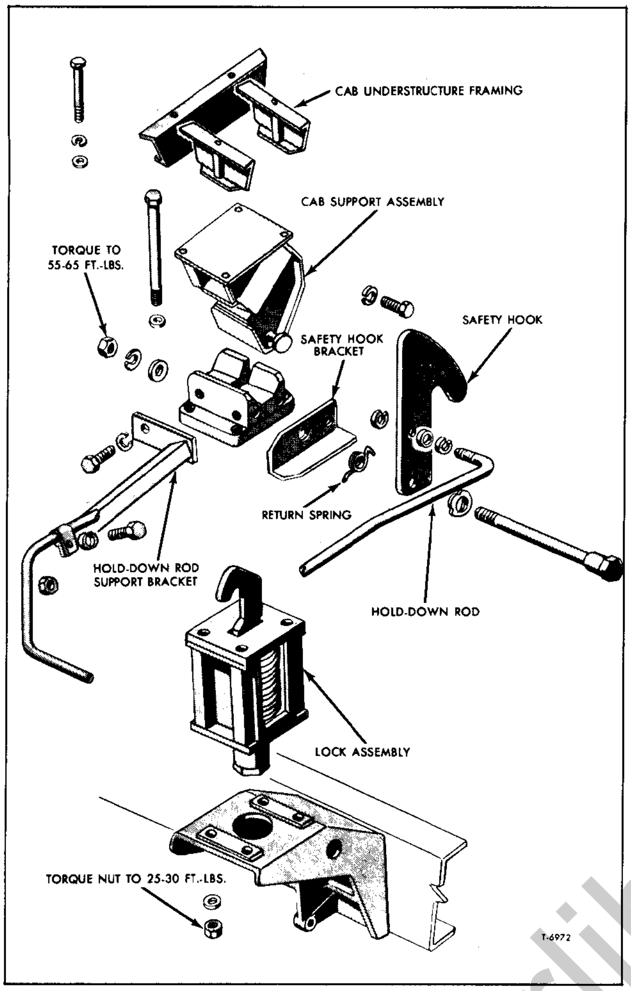


Figure 9—Rear Mounting and Hydraulic Latch

1. Remove hydraulic oil line if not previously done.
2. Loosen the cylinder cap with strap wrench as shown in figure 11, then use strap wrench and remove cylinder barrel from body.
3. Remove cap and O-ring; remove piston and O-ring and then wiper seal from bore from inside cylinder at external threaded end.
4. Clean and inspect all parts for damage. Replace O-rings, wiper seal and damaged parts.

NOTE: Make sure no dirt or foreign material gets in cylinder or piston.

5. Carefully install new wiper seal in cylinder bore cavity. Install piston O-ring, cap O-ring, coat piston with petrolatum jelly, install piston in cylinder, and screw cap in cylinder finger tight.
6. Install cylinder in body and tighten with strap wrench and then tighten cap to cylinder (fig. 11).
7. Install hydraulic line fitting in cap if previously removed. Connect hydraulic line and bleed as described later.

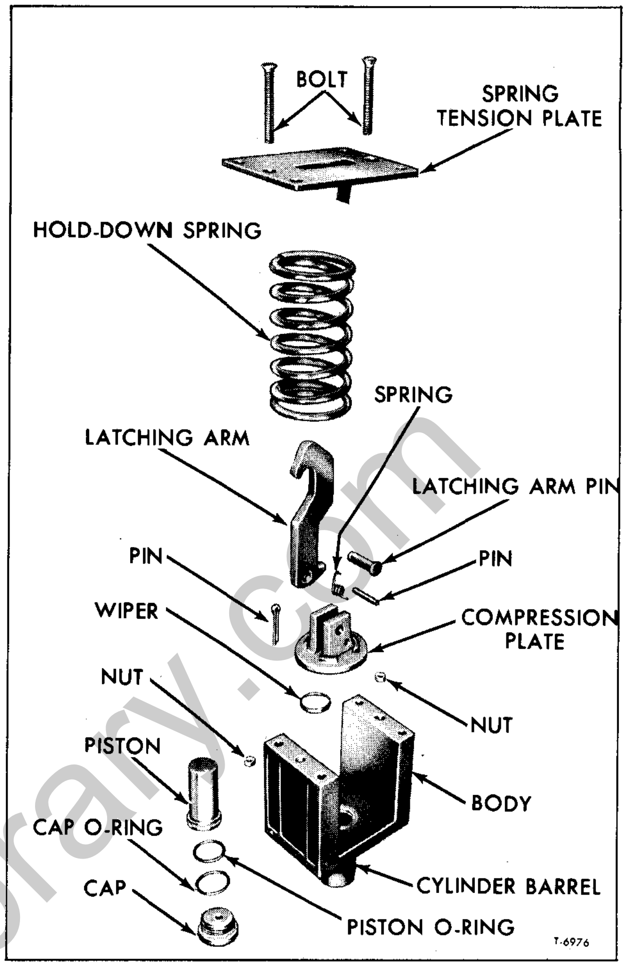


Figure 10—Tilt Cab Lock

SPRING REPLACEMENT (Fig. 10)

WARNING - Tension on hold down spring is considerable and must be released or applied gradually with caution.

1. With cab lock assembly removed from vehicle place in a large vise and loosen two bolts on each side of spring gradually and releasing vise against hold down spring tension.

NOTE: When the two nuts are loosened to end of two bolts there is still about ½-inch of tension on spring and it will be necessary to hold cab lock assembly in vise until all tension is removed from hold down spring.

2. Remove tension plate, spring, latching arm and compression plate from body.

NOTE: Latching arm can be removed from compression plate by removing cotter pin and pin. Also latching arm return spring and pin can be removed if necessary (fig. 10).

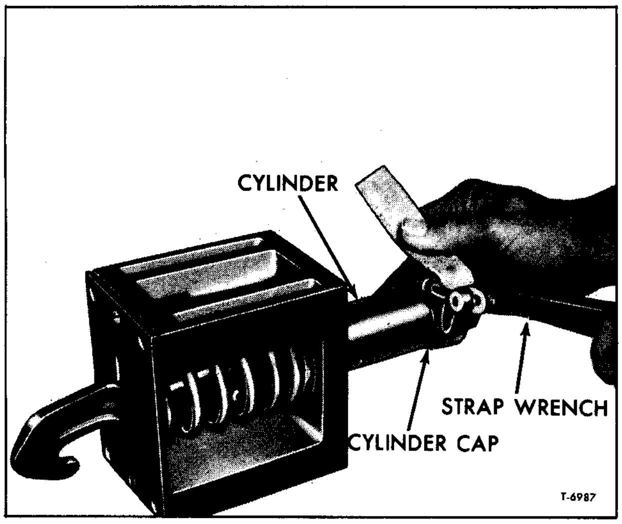


Figure 11—Disassembly of Cab Lock Cylinder

3. To reassemble install compression plate (complete with latching arm) in body, then spring, tension plate and mount this assembly in large vise to compress spring.

4. Compress spring carefully until two bolts and nuts can be installed. Gradually compress spring and tighten nuts until tension spring plate is tight against body.

5. Install on vehicle as described under cab lock assembly replacement.

SYSTEM BLEEDING PROCEDURE (Fig. 12)

1. Connect all hydraulic lines to pump and cylinder.

NOTE: Use sealing compound on all pipe threads before assembly.

2. Firmly tighten all connections except the two (2) at the tilt cylinder and one (1) each at rear cab mounting hydraulic latches. Connections should be tightened snugly as they will be loosened later. Lines at tilt cylinder should be bled first; lines at hydraulic latches will be bled last.

3. Remove pump filler plug and fill pump reservoir with special hydraulic oil (MIL-H-5606A specification) until oil flows from reservoir standpipe.

NOTE: DO NOT fill reservoir through relief vent plug opening.

4. Loosen connection 1/4-turn at tilt cylinder pull port (rod end of tilt cylinder).

5. Place control valve pump lever in "DN" position and slowly actuate pump handle until air-free oil flows from loose connection at tilt cylinder. Tighten connection firmly.

6. Fill pump reservoir until oil flows from standpipe.

7. Loosen connection 1/4-turn at tilt cylinder push port (base end of tilt cylinder).

8. Place control valve pump lever in "UP" position and slowly actuate pump handle until air-free oil flows from loose connection at tilt cylinder. Tighten connection firmly.

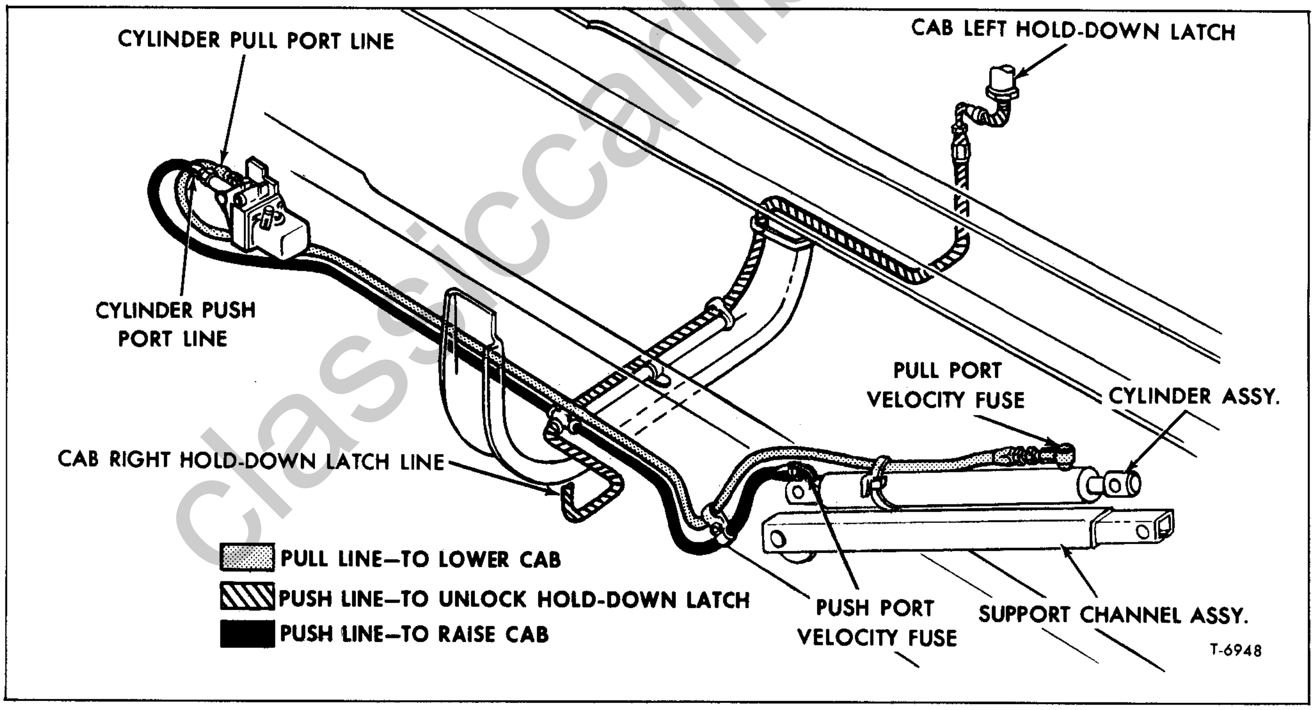


Figure 12—Cab Tilt Mechanism Lines

9. Repeat bleeding procedure for left cab mounting hydraulic latch, and then for right cab mounting hydraulic latch.

10. After entire system has been bled and all connections tightened, place pump valve lever in "DN" position and actuate handle until tilt cylinder rod bottoms. Fill reservoir and install reservoir filler hole plug.

CAB MOUNTINGS

Cab is supported at four points; two pivot-type mountings at the front (fig. 8) and two shear-type mountings at the rear (fig. 10). Front pivot mountings are used in conjunction with cab tilting mechanism. Flexible cushions at rear mountings protect cab assembly from vibration and shock.

Cab rear mountings incorporate a hydraulic actuated hook type hold-down mechanism and shear type resilient insulators. The right rear mounting has an adjoining safety catch.

MAINTENANCE

No systematic service is required other than a periodic check of mounting attaching bolt torques. Refer to figures 8 and 10 for bolt torques.

If hydraulic leaks occur at rear mounting cab latches, refer to bleeding procedure described in preceding "CAB Tilting Instructions."

CAB REPLACEMENT

Due to massive size of cab assembly and to assure safe cab replacement, a hoist of 2-ton minimum capacity with special adapters are necessary. Four or more heavy support blocks are required to rest cab once it is lifted from chassis. Approximate cab weights are:

54" BBC - 965 lbs.
74" BBC - 1050 lbs.
86" BBC - 1165 lbs.

NOTE: Hoist attachments can be improvised locally.

REMOVAL (Fig. 13)

1. Disconnect cables from batteries.
2. Drain cooling system since heater hoses will be disconnected.
3. Exhaust air supply from air tanks by opening tank drain cocks.

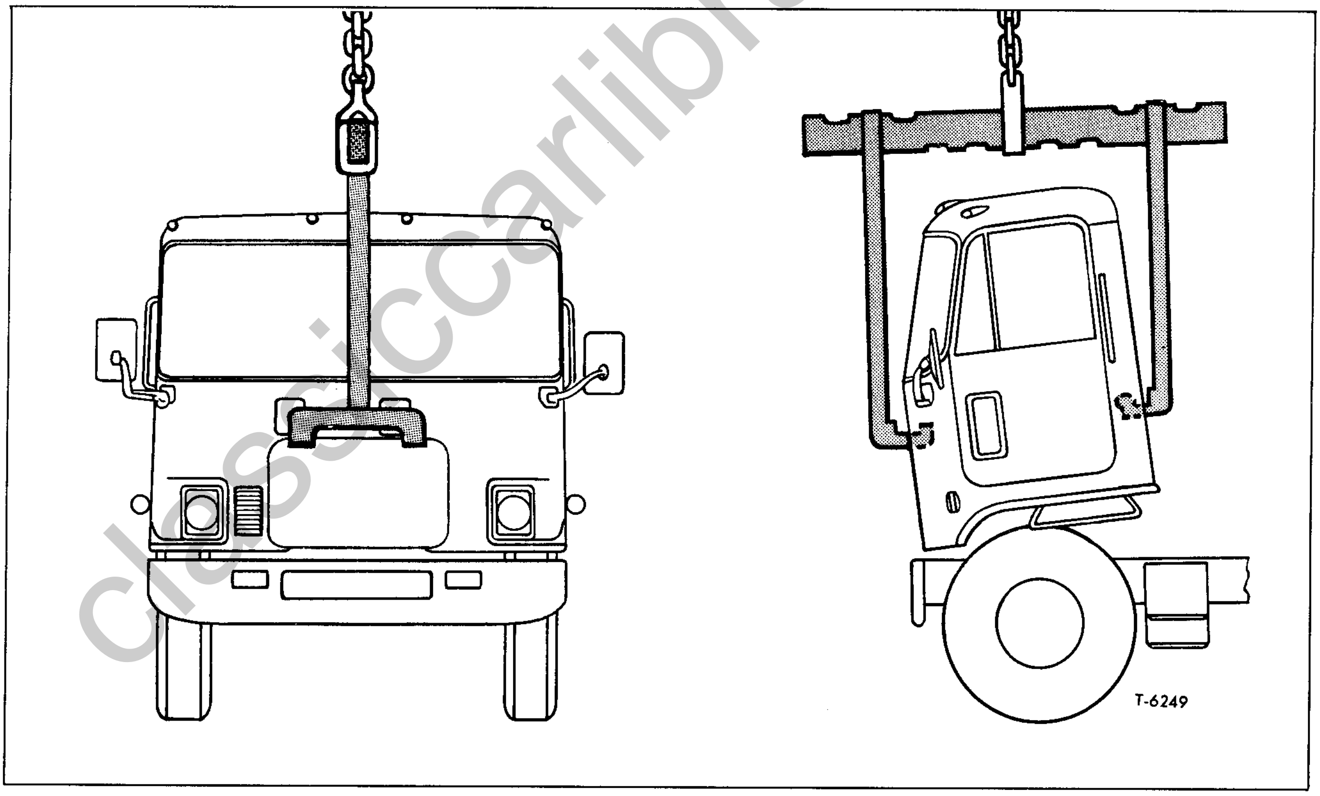


Figure 13—Cab Lifting Sling Attachment

4. Under right dash panel, remove washer fluid reservoir from bracket and wiring harness cover. Disconnect wiring harness retainer and multiple contact circuit connector. The lower portion of wiring harness will be pulled through cab floor when cab is tilted.

5. Tilt cab to gain access to clutch linkage, coolant hoses, air lines, and wiring.

6. Depressurize air conditioning system (if equipped) as described in "HEATING AND AIR CONDITIONING" (SEC. 1C). Remove refrigerant hose at A/C compressor low pressure fitting. Remove hose at A/C receiver-dehydrator refrigerant exit fitting. Be sure to cap the disconnected A/C hoses and fittings to prevent contaminants from entering system.

7. Disconnect cab heater hoses at engine water filter.

8. On right side of cab, remove four cap screws that attach wiring harness retainer plate to cab understructure. Follow electrical cable down to rear of right headlight housing and disconnect wiring harness at headlight terminals. The engine portion of the main wiring harness, which was previously disconnected to a multiple contact circuit connector under right cab dash, can now be pulled through opening in cab floor. Be careful not to damage connector housing at end of wiring harness.

9. Remove splash shield from beneath left side of cab understructure to gain access to clutch linkage and brake application valve.

10. Remove clutch idler outer lever pin and separate clutch relay rod assembly from lever. Fasten relay rod to cab understructure with a small piece of cord or wire.

11. Remove clamp bolt which retains U-joint coupling to splined steering gear shaft. Mark position of steering gear shaft-to-U-joint coupling to assure alignment of steering wheel spokes upon installation. Lift U-joint coupling from steering gear shaft and tie to understructure with cord.

12. At brake application valve, disconnect and cap air lines coming from chassis.

13. Disconnect oil pressure line at engine fitting.

14. Disconnect tachometer cable from rear of engine.

15. Disconnect speedometer cable from transmission (or front wheel).

16. All wiring, lines, and linkage between cab and chassis should now be disconnected with the exception of the hydraulic cylinder linkage and cab tilt pivot bolts. However, in the event of special equipment, disconnect linkage at most convenient point.

17. Lower cab after placing wooden blocks in the "V" of both rear mountings to prevent cab locks from latching.

18. Remove radiator grill and moulding.

19. Attach hoist front adapter to upper edge of grill opening in cab. Attach hoist rear adapter to cab rear understructure (fig. 13). Raise hoist slightly to take weight of cab assembly from front mountings. Be sure adapters are positioned properly and are contacting cab understructure framing.

IMPORTANT: Be sure hoist and adapters will support weight of cab assembly. The 54" BBC cab weighs approximately 965 pounds; the 74" and 86" BBC sleeper cabs weigh approximately 1050 and 1165 pounds respectively.

NOTE: Do not attempt to lift cab by placing a beam through cab door openings.

20. Remove hydraulic cylinder clevis pin and inner channel clevis pin at right cab pivot brace assembly. Do not open tilt mechanism hydraulic lines.

21. Slightly loosen main pivot bolt at each pivot bracket. Remove six bolts that attach each pivot assembly to frame bracket.

22. Carefully raise cab from chassis. Lower cab onto suitable support blocks that will contact understructure framing. Remove hoist adapters.

INSTALLATION (Fig. 13)

1. Attach hoist adapters and safely raise cab over chassis. With aid of assistants, slowly lower cab into position. Install bolts that attach each forward pivot assembly to frame bracket. Torque each pivot bracket attaching bolt to 90-110 foot-pounds. Tighten each main pivot bolt to 210-230 foot-pounds torque.

2. Install hydraulic cylinder and inner channel clevis pins at cab right pivot brace assembly.

3. Operate hydraulic pump until hydraulic cylinder supports cab in tilted position. Install safety pin in locking slots of support channel. Remove hoist adapters from cab.

4. Install all connecting lines, hoses, linkage, and wiring. In general, follow, in reverse order, steps 1 through 18 of cab "Removal" procedure.

IMPORTANT: Do not operate vehicle until all lines, linkage and wiring are properly installed and inspected. If cab tilt mechanism hydraulic lines were opened, be sure to bleed system as described previously. Also, check to see if rear of cab is resting properly in rear mountings and that hydraulic latches are operating correctly as cab is lowered through use of tilt mechanisms. Adjust rear mounting-to-frame bolts as necessary and tighten to 25-30 foot-pounds torque.

DOORS

Cab door opening is constructed of a continuous aluminum extrusion. A formed steel stamping is riveted to the extrusion at the door lock area. Mounted behind the stamping is the door lock mechanism and remote control assembly. The striker bolt is mounted on rear edge of door and is surrounded by a foam rubber insulator.

Cab doors are of double-wall construction and are mounted to cab pillar by a continuous type hinge. Manually operated door windows are provided with an electric power window available as optional equipment. Door components such as striker bolt, window regulator and windows may be replaced without removing door from cab.

DOOR REPLACEMENT

REMOVAL (Fig. 14)

1. Remove vertical bolt from check strap bracket on door.
2. If removing right door equipped with power-assist window, disconnect door wiring harness from beneath right dash panel.
3. With aid of assistant to support weight of door, remove seven cap screws which attach hinge to cab pillar.

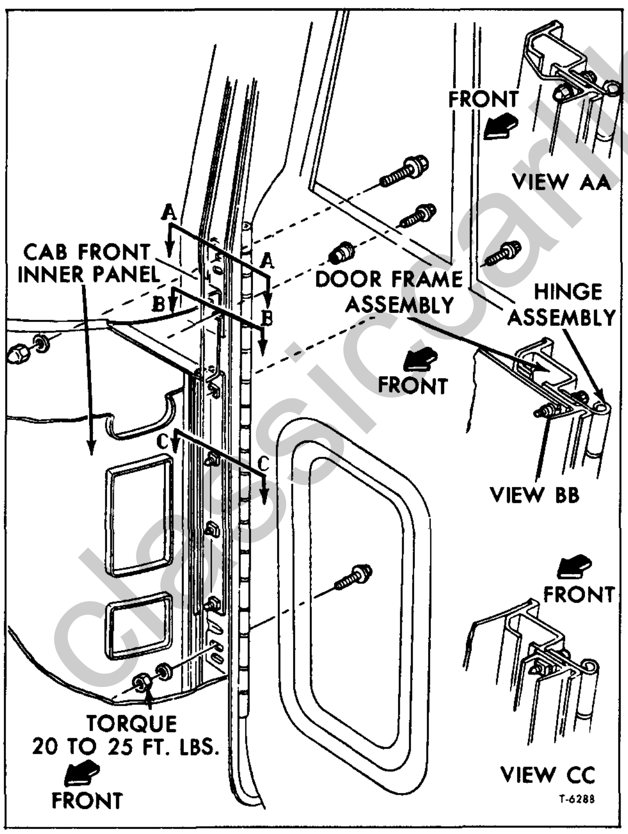


Figure 14—Cab Door Hinge

INSTALLATION

With aid of assistant, lift door to cab opening and install seven hinge attaching cap screws. Tighten cap screws to 20-25 foot-pounds torque after adjusting door in cab opening as described later under "DOOR ADJUSTMENTS". Reconnect door window control wiring harness (if used).

DOOR ADJUSTMENTS

Cab entrance door can be adjusted to cab opening by loosening cap screws which attach hinge to door and to cab pillar.

DOOR "UP" OR "DOWN" ADJUSTMENT (Fig. 14)

1. From rear of door, remove seal, striker bolt, and spacers.
2. Remove vertical bolt from check strap bracket on door to allow better access to hinge attaching screws.
3. Slightly loosen hinge-to-door cap screws then raise or lower door to desired position. Equal clearances should exist at top and bottom of door.
4. Tighten cap screws to 20-25 foot-pounds torque and continue with following procedure.

DOOR "IN" OR "OUT" ADJUSTMENT (Fig. 14)

1. Slightly loosen hinge-to-pillar cap screws.
2. Push door in or out from cab opening until desired position is obtained. Door outer panel should be flush with cab outer panel at hinge area.
3. Tighten cap screws to 20-25 foot-pounds torque and install door check strap pin.
4. Install and adjust striker bolt as directed in next procedure.

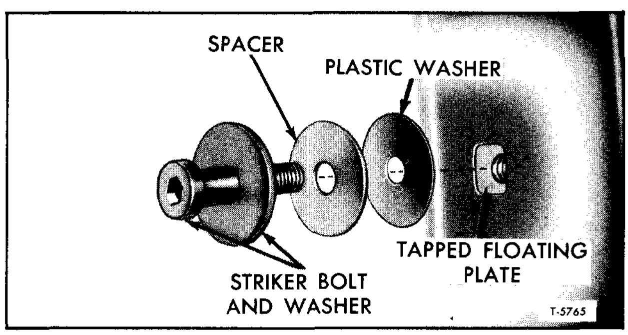


Figure 15—Door Striker Bolt and Washers

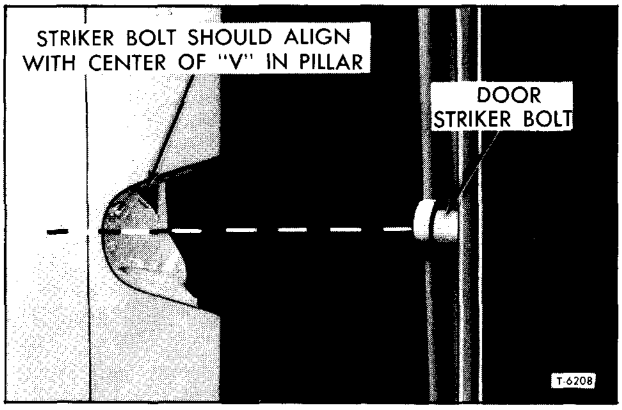


Figure 16—Sight Checking Striker Bolt Alignment

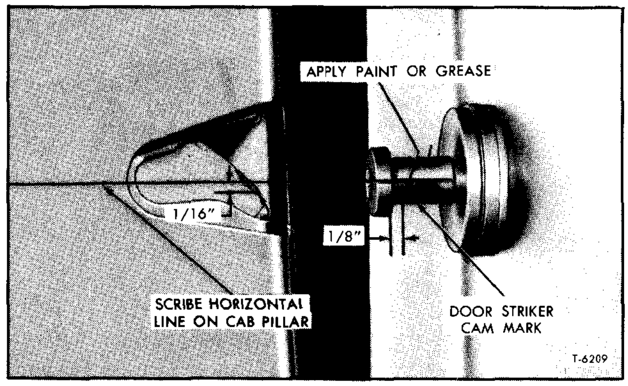


Figure 17—Striker Bolt Alignment

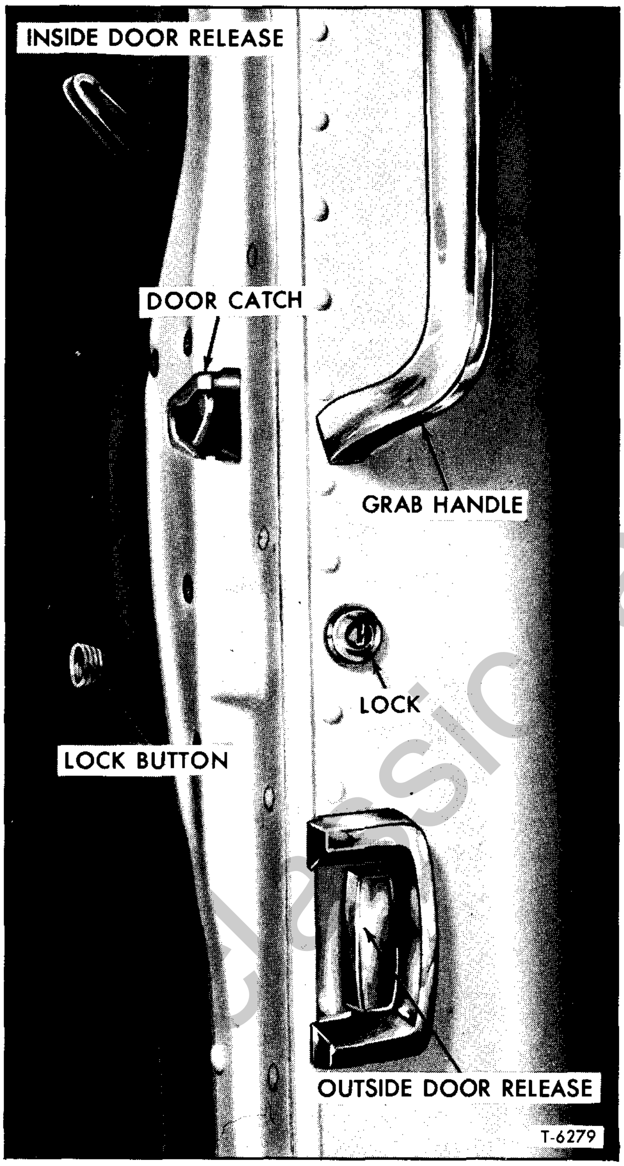


Figure 18—Door Release Components

STRIKER BOLT REMOVAL (Fig. 15)

The door striker consists of a special bolt and washer assembly which is threaded into a tapped, floating cage plate in rear edge of door (fig. 15).

1. Remove sponge rubber seal surrounding door striker bolt. Clean away old adhesive.
2. Mark around position of striker bolt spacer on edge of door.
3. Insert a hex-head wrench into head of striker bolt, then turn bolt counter-clockwise from plate in door.
4. Reverse removal procedure to install striker bolt. Make sure the thin plastic washer is positioned against door surface and center the bolt washer within marks on door edge.
5. If door has been removed and then installed or aligned in opening, the door should not be closed completely until a visual check is made to determine if lock cam will engage the striker bolt correctly. Center of striker bolt should be in direct alignment with "V" slot in door. See figure 16. If necessary, reposition striker bolt as directed below under "Striker Bolt Adjustment."

STRIKER BOLT ADJUSTMENT

Striker bolt is adjustable vertically and transversely after loosening the bolt with a 5/16-inch hex wrench. The bolt fore and aft adjustment is obtained by use of shim spacers located between the bolt washer and the cab door. Figure 15 illustrates location of bolt, washers, and spacer with sponge rubber seal removed.

Striker Bolt Fore and Aft Adjustment

1. To check striker bolt for proper fore and aft adjustment, smear grease or paint to contact side of bolt as shown in figure 17.
2. Slowly close door until lock cam just contacts the side of striker bolt and makes an impression in the grease or paint.
3. Measure distance between head of bolt and

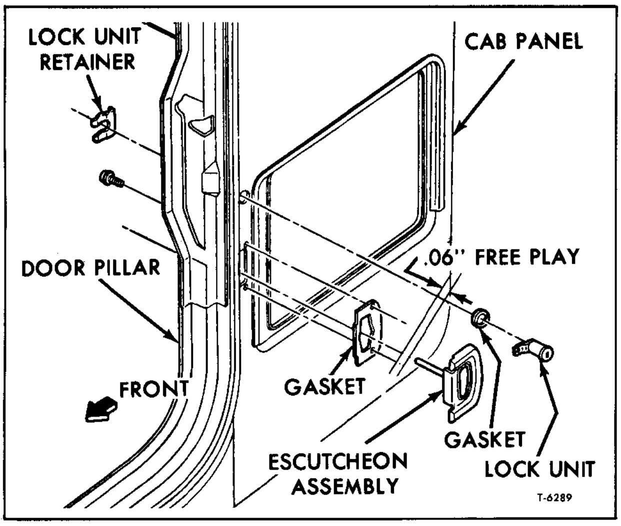


Figure 19—Door Lock Cylinder Components

the cam impression in grease. Distance should measure 1/8-inch as shown in figure 17. This dimension is necessary to assure that the head of striker bolt will ride at center of nylon shoe.

To obtain this dimension, remove the striker bolt and install or remove shim spacers. Spacers are available in two thicknesses: 5/64-inch and 5/32-inch. Make sure the thin plastic washer is located against door surface.

After obtaining proper fore and aft adjustment, tighten bolt snug only at this time and proceed with "Striker Bolt Height Adjustment."

Striker Bolt Height Adjustment

This adjustment is important to assure that the right proportion of door's weight will rest on striker bolt when door is closed. If bolt is improperly positioned, door will be difficult to close and an extra load will be placed on hinges which could pull door out of alignment.

To make positive check, perform the following:

1. Mark a horizontal line through center of "V" slot and on door lock cam as shown in left view of figure 17.

2. Smear some grease or paint on contact edge of lock cam.

3. Slowly close door until cam barely contacts striker bolt. Open door and check contact mark on edge of cam. Mark should be located approximately 1/16-inch below horizontal mark if properly aligned.

4. If necessary, raise or lower the loosened striker bolt up or down by tapping on the washer or spacer at base of striker bolt. DO NOT TAP ON HEAD OF BOLT.

Door Rear Edge "In" or "Out" of Adjustment

To align door rear surface flush with cab, proceed as follows:

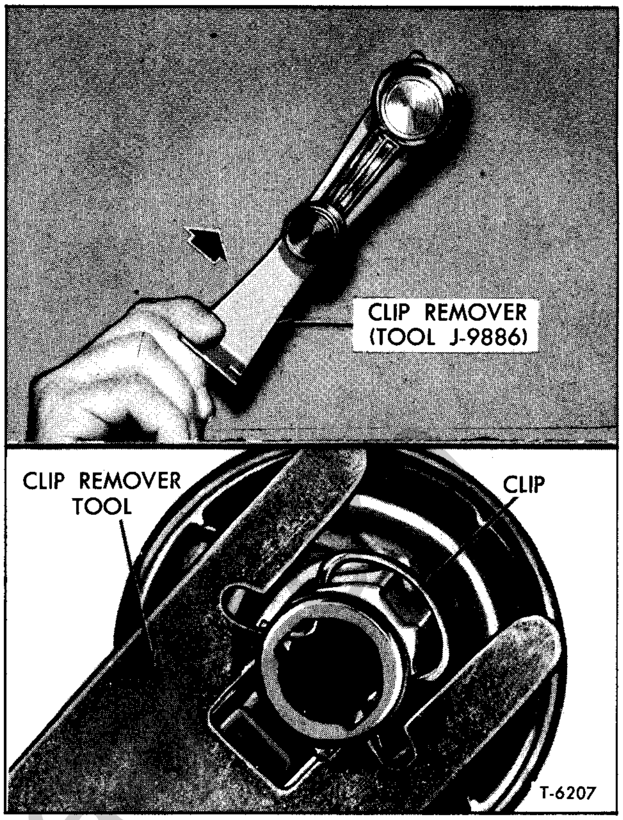


Figure 20—Door Inside Handle Replacement

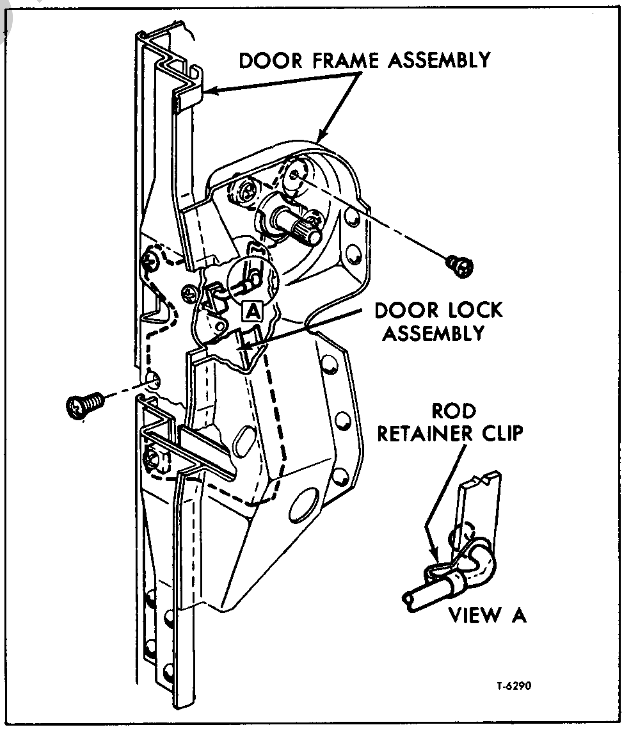
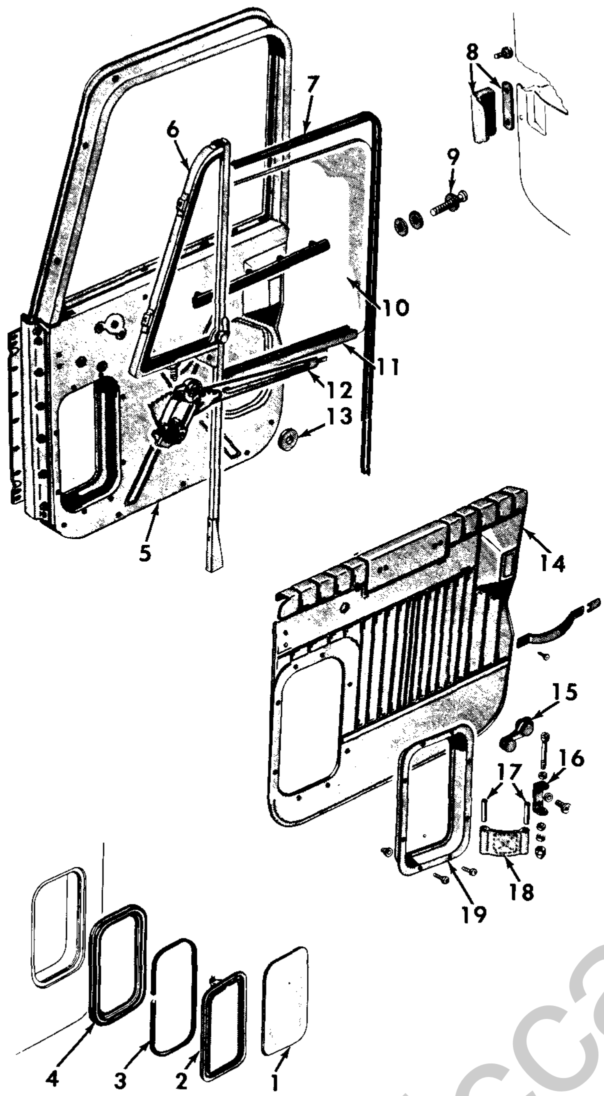


Figure 21—Remote Control and Lock Mechanism



1 Glass (Optional)
2 Vent Door (Std.)
3 Seal Filler
4 Glass Seal
5 Door Assembly
6 Vent and Division Channel Assy.
7 Run Channel
8 Outer Handle and Gasket
9 Striker Bolt
10 Door Glass
11 Guide Rail Assy.
12 Regulator Assy.
13 Handle Seal
14 Door Trim Panel
15 Regulator Handle
16 Door Check Bracket
17 Bracket Spacer
18 Door Check
19 Vent Door or Glass Opening Trim Panel

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Figure 22—Door Components (w/Manual Window Control)

1. Mark a horizontal line at top of striker bolt base washer or spacer on door.
2. Loosen striker bolt slightly, then tap against bolt base washer, to move bolt "in" or "out" as necessary to locate door surface flush with cab surface when door is closed. Before tightening the striker bolt make sure top bolt base washer is contacting the horizontal mark on door. Final tighten striker bolt and install sponge rubber seal with rubber adhesive.

NOTE: This door to pillar fastener is an important attaching part in that it could affect the performance of vital components and systems, and or could result in major repair expense. It must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

DOOR RELEASE AND LOCK CYLINDER REPLACEMENT

The outside door release is of the push-button type screw retained to cab outer panel (fig. 18). Lock cylinder is retained to cab panel by means of a special clip positioned around lock cylinder body.

REMOVAL (Figs. 18 and 19)

1. Slide seat assembly forward as far as possible.
2. From inside cab, remove two cross-recessed screws which attach door release to cab. Remove door release assembly and gasket from outside of cab.
3. Behind lock mechanism housing, or through door release cab opening, pull lock cylinder retainer clip from lock cylinder grooves by grasping retainer lip with long-nosed pliers. Tilt lock cylinder to permit lug to disengage from lock mechanism lever. Remove lock cylinder and gasket from outside cab.

INSTALLATION (Fig. 19)

1. With gasket in position on lock cylinder, insert cylinder in door and engage lug over lock mechanism lever.

2. While holding cylinder, insert legs of retainer into grooves of lock cylinder body. Be certain legs of retainer are fully engaged.

3. With gasket in position, place door release in cab opening and install two cross-recessed screws. There must be a .06-inch clearance between release button plunger and lock mechanism lever. If insufficient clearance

is provided, remove release assembly and adjust by threading plunger deeper into release button.

4. Insert key into lock cylinder and check operation of lock mechanism. Press door release button to determine if mechanism operates properly and proper plunger clearance is provided.

INSIDE HANDLE REPLACEMENT

Window regulator handle and door release inside handle are retained on splined shafts by spring clips. Mounted on shaft beneath door release inside handle is an escutcheon plate. (Fig. 20).

1. Insert clip remover tool (J-9886) beneath handle and force spring clip from grooves in base of handle. DO NOT LOSE SPRING CLIP.

2. Note the position of handle and then remove handle (and escutcheon plate) from splined shaft.

3. To install, insert spring clip in handle. Refer to lower view of figure 20 for correct position of clip on handle grooves.

4. To install, place handle (and escutcheon plate) in original position and then force handle, with installed spring clip, over splined shaft until clip becomes fully engaged.

LOCK MECHANISM AND REMOTE CONTROL REPLACEMENT

The lock mechanism and remote control are located at cab pillar. Both components should be removed at the same time.

REMOVAL (Fig. 21)

1. Remove door release inside handle and escutcheon plate as instructed previously.

2. Remove door inside lock knob which is threaded on lock rod.

3. Remove four cross-recessed screws which attach lock mechanism to cab pillar.

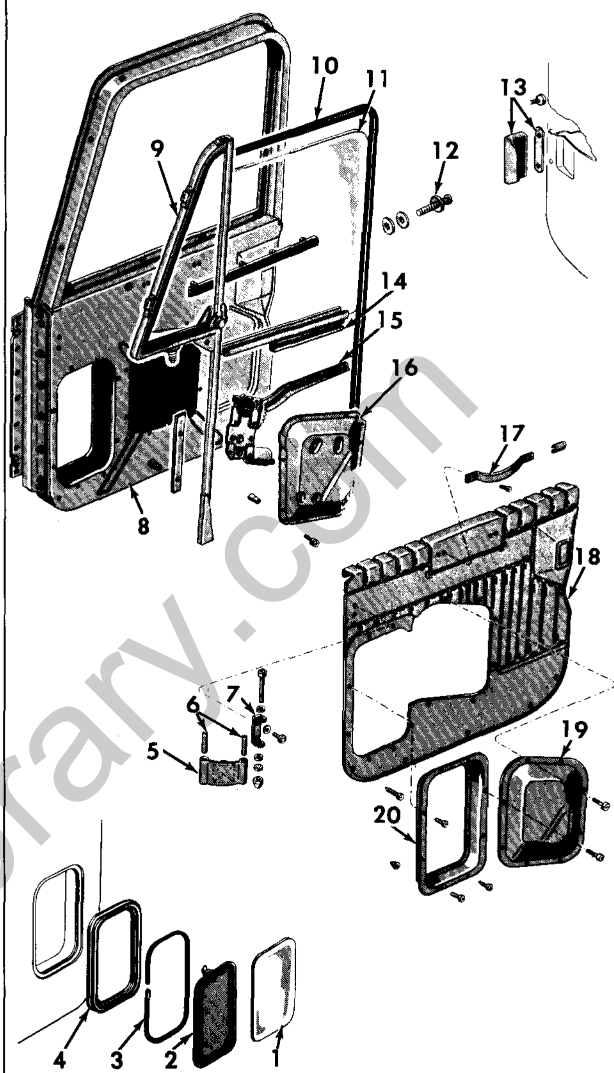
4. Remove three cross-recessed screws which attach remote control assembly to pillar reinforcement panel.

5. Lower both assemblies down between reinforcement and cab side panel.

6. Separate components by disengaging fasteners as required.

INSTALLATION (Fig. 21)

Install lock mechanism and remote control assembly in reverse order of "Removal" procedures. Tighten screws firmly then check operation of components.



1 Glass (Optional)
2 Vent Door (Std.)
3 Seal Filler
4 Seal
5 Door Check
6 Bracket Spacer
7 Door Check Bracket
8 Door Assembly
9 Vent and Division Channel Assy.
10 Door Glass Run Channel
11 Door Glass
12 Striker Bolt
13 Outer Handle and Gasket
14 Guide Rail Assy.
15 Window Regulator and Motor Assy.
16 Regulator Mounting Panel
17 Assist Handle
18 Door Trim Panel
19 Trim Panel Cover
20 Vent Door or Glass Opening Trim Panel

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Figure 23—Door Components (w/Electric Window Control)

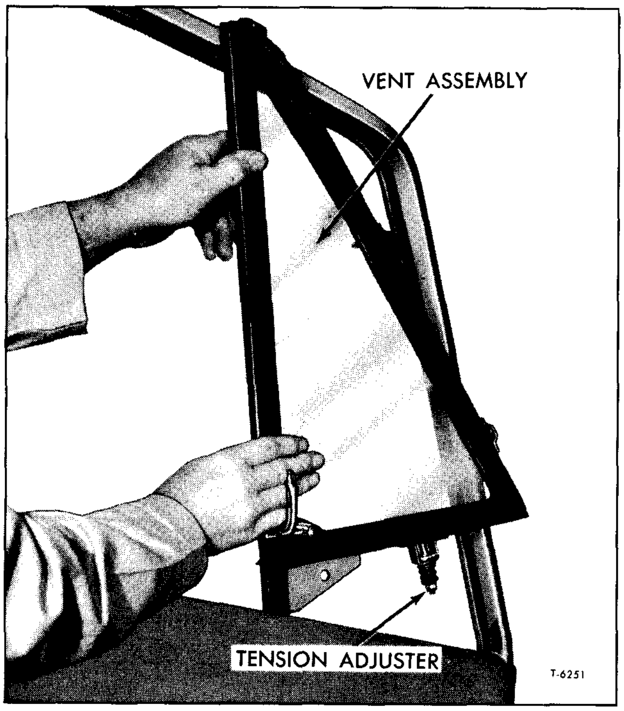

Figure 24—Replacing Vent Glass

DOOR WINDOW REGULATOR REPLACEMENT

Two types of door window regulator mechanisms are offered; one is manually-operated, the other is electric power-assisted (right hand door only).

MANUAL WINDOW REGULATOR REPLACEMENT (Fig. 22)

Removal

1. Remove fresh-air ventilator or safety glass from lower quarter of door as directed in "GENERAL CAB MAINTENANCE" (SEC. 1A) of this publication.
2. Remove eight screws that attach ventilator trim panel to lower quarter of door.
3. Lower window to full-down position and then remove regulator handle as directed previously.
4. Remove check strap and bracket from inside door panel.
5. Remove cross-recessed screws which attach trim panel to door.
6. Remove grab handle shields with a flat bladed tool. Remove attaching screws and remove both grab handle and trim handle from door.
7. Remove four screws which attach window regulator to door inner panel.
8. Tilt regulator assembly to remove arm roller from track then carefully lower regulator assembly through opening in lower quarter of door.

Installation

Install window regulator in reverse order of "Removal" procedures. Before installing trim panel, slip regulator handle (without spring clip) on splined shaft then roll up window to be sure regulator mechanism is operating freely.

ELECTRIC WINDOW REGULATOR REPLACEMENT (Fig. 23)

Removal

1. Lower window to full-down position.
2. Remove cross-recessed screws which attach trim panel to window regulator motor housing.
3. Remove cross-recessed screws which attach motor housing to door inner panel.
4. Tilt window regulator motor housing to allow arm roller to slide from window track. Disconnect wiring harness from motor and move assembly from door.

Installation

Install electric window regulator in reverse order of "Removal" procedures. Before installing trim panel, check for proper operation of electric motor and regulator mechanism.

DOOR VENT GLASS REPLACEMENT

1. Squirt solvent on rubber filler all around glass frame to soften old filler. When seal softens sufficiently, pull glass and old filler from glass channel.
2. Thoroughly clean the inside of the glass channel with sandpaper to remove all rust and foreign matter.

NOTE: Ventilator glass rubber filler is supplied in various thicknesses for select fit between glass and channel.

3. Cut new piece of glass channel rubber filler two inches longer than required. Position filler (soapstoned side away from glass) over that part of glass which will be inserted in frame. Punch together projecting length of filler at each end to retain filler in place during installation.
4. Brush inner channel of glass frame with soap solution. Press glass and filler into frame until firmly seated. Purpose of soap solution is to facilitate assembly. DO NOT USE GREASE OR OIL.
5. Trim off excess filler material around frame and at end of frame.

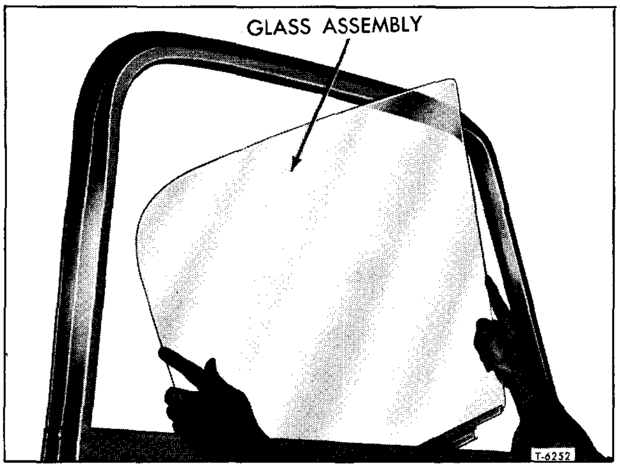

Figure 25—Replacing Door Glass

DOOR VENT WINDOW TENSION ADJUSTMENT

Vent windows are of friction type having a theft-resistant latch. Friction mechanism consists primarily of a coil spring mounted on vent window lower pivot, which exerts frictional force against mounting lower support.

If friction mechanism is adjusted too tight, it will be difficult to open or close vent. Too loose an adjustment will result in a fluttering vent or one having a tendency to close with wind pressure.

If necessary to change vent friction, perform procedures as follows:

1. Remove eight screws which attach ventilator trim panel to lower quarter of door.
2. Reaching up through opening in door, turn adjustment nut on vent window pivot with a speed wrench to obtain 3 1/2 to 7 pounds force when applied perpendicular to glass at locking handle (Refer to figure 24). Use either a push or pull type spring scale positioned perpendicular to rear edge of vent glass.
3. Install trim panel to lower quarter of door.

DOOR VENT WINDOW ASSEMBLY REPLACEMENT

REMOVAL (Figs. 22 and 24)

The division channel between the door window glass and the door vent is part of, and is removed with, the vent window assembly.

1. Lower window to full-down position.
2. Remove the fresh air ventilator/safety glass and trim panel from lower quarter of door.
3. Remove two division channel retaining screws from bottom of door. (Refer to figure 22).
4. Remove three screws which retain vent window to upper front edge of door.

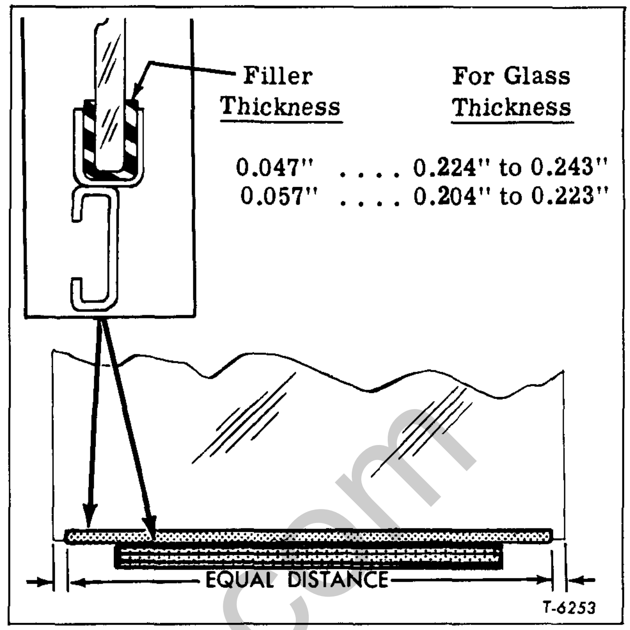

Figure 26—Door Window Glass Assembly

5. Unlatch vent window and swing out. Just below vent window, remove plug from door inner panel. Through hole, remove vent window frame attaching screw. (Refer to figure 22).
6. At end of run channel, next to upper end of division channel (vent window frame), pry end of rubber run channel from door frame and pull downward from top of door.

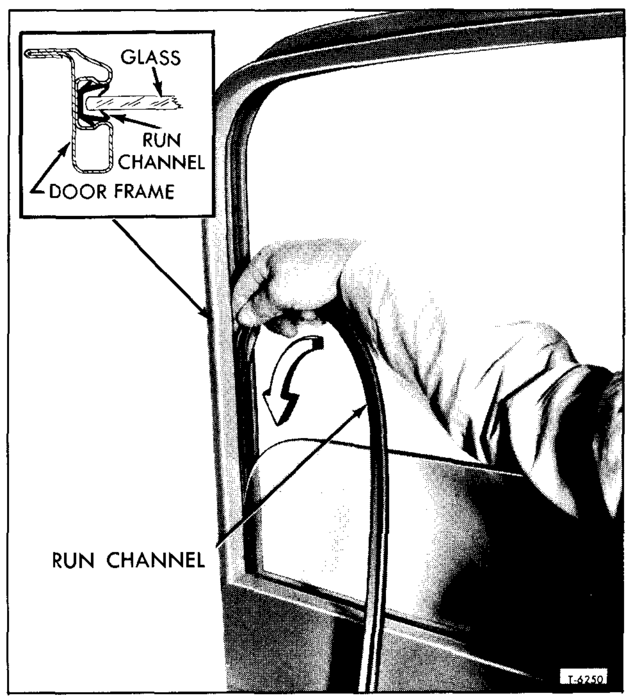

Figure 27—Installing Glass Run Channel

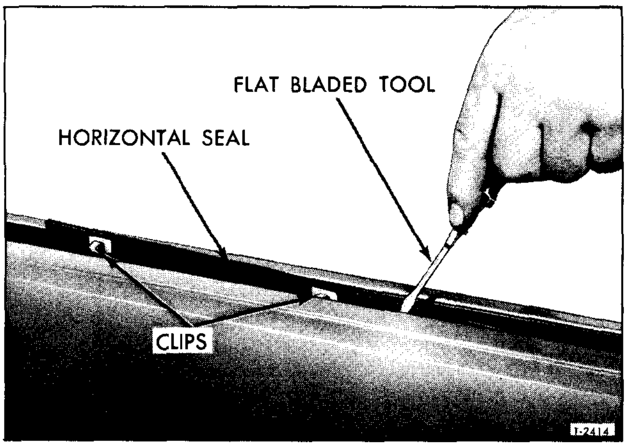

Figure 28—Removing Horizontal Seal

7. Tilt division channel and vent window assembly towards lowered window and then carefully lift assembly out of door (fig. 24).

Important: Do not permit the run channel to kink.

INSTALLATION (Figures 22 and 24)

Install vent window assembly in reverse order of "Removal" procedures. Be sure rubber tip around forward portion of vent window is properly mated to vent window frame. Adjust vent window pivot tension as directed previously. Press rubber run channel back into door frame.

DOOR WINDOW GLASS REPLACEMENT

REMOVAL (Fig. 24)

1. Remove the vent window assembly as directed previously under "Door Vent Window Assembly Replacement."
2. Regulate window to two-thirds closed position.
3. Disengage the glass assembly from the regulator arm roller by shifting glass assembly towards front of door. Lift window up and out of door.
4. If desired, the horizontal seal strips can be replaced using a flat-bladed tool to pry strips from door as shown in figure 28.
5. Also if desired, the door glass run channel assembly can be removed at this time. Pull run channel from door. (Refer to figure 27.)
6. To replace the glass in glass channel, perform the following:

a. Squirt solvent along glass filler on both sides of glass to soften seal. Remove glass from channel when filler is sufficiently soft. Pull rubber filler from channel.

b. Thoroughly clean inside of glass channel, removing all rust and foreign matter.

c. Window glass rubber filler is supplied in two thicknesses - 0.047" and 0.057" for select fit between glass and channel.

d. Cut new piece of channel filler slightly longer than channel. Position filler (soapstone side away from glass) around glass.

e. Brush inside of channel with a light application of liquid soap solution to facilitate installation. DO NOT USE GREASE OR OIL.

f. Press channel on filler and glass until firmly seated.

IMPORTANT: Make sure channel ends are equal distance from edge of glass (fig. 26) and that regulator arm track in channel is facing the right direction in respect to rounded and squared corners at upper edge of glass. Trim off excess filler material along channel and at ends.

INSTALLATION (Fig. 25)

1. If glass run channel was removed from door framing, install channel by pressing run channel onto place around door frame.
2. If the glass horizontal seal strips were removed from door, press new seal strips into position making sure all strip attaching clips are fully engaged.
3. Lower the door window assembly into door.
4. Engage glass channel on the roller of regulator arm. NOTE: Regulator arm should be in window two-thirds closed position.
5. Install vent windows assembly as directed previously.
6. Check operation of vent window assembly and window regulator for possible binding.

DOOR GLASS RUN CHANNEL REPLACEMENT

REMOVAL (Fig. 27)

1. Roll window to bottom of door.
2. At upper end of channel, next to vent window frame, pry end of channel from door using a small flat-bladed instrument.
3. Continue to pull channel downward from top of door, then upward to remove from side frame of door.

INSTALLATION (Fig. 27)

1. Apply thin coat of silicone type lubricant to back and sides of run channel.
2. Start end of run channel into door side frame, then force it downward in manner shown in figure 27. By engaging length of channel required to butt against vent window frame, the amount of channel to be inserted downward can be determined. Use thumbs to press channel into position.

NOTE: The run channel can be inserted downward more readily if the window is rolled up and down during the process. If run channel cannot be installed as instructed, it will then be necessary to remove the door window glass.

Referring to inset of figure 27, be sure to properly position run channel so that channel lips lock behind grooves of window frame.

DOOR WINDOW GLASS HORIZONTAL SEALS REPLACEMENT

1. Remove the vent window and door window as directed previously under applicable headings.
2. Using a thin flat-bladed instrument, pry seals from door panel in manner shown in figure 28. Pry a small amount at each fastener to prevent seal channel distortion.
3. To install, press seal assembly evenly into door panel.
4. Install door glass.

DOOR WEATHERSTRIP REPLACEMENT

Cab door sealing consists of a moulded rubber weatherstrip cemented around entire periphery of cab door opening. A second weatherstrip is cemented to front pillar of door opening.

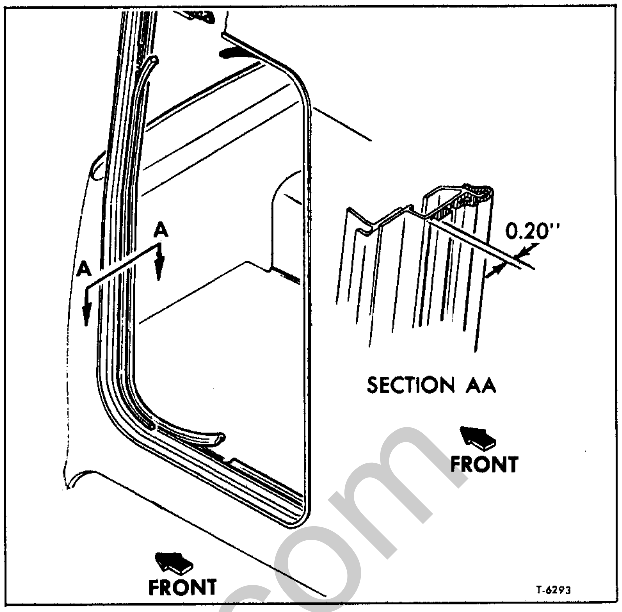

Figure 29—Door Weatherstrip Seal Installed

All, rust, road dirt and grease or oil must be completely removed as should all old cement and bits of old weatherstrip. After removing all foreign material from door opening surface, wipe down with rubber cement solvent or equivalent. Use cement specially for weatherstrip installation. Install new weatherstrip with ends of weatherstrip positioned as shown in figure 29.

IMPORTANT

Always wear heavy gloves to prevent possible injury when handling glass.

For information on servicing seats, refer to next page.

SEATS

STANDARD SEAT

Standard driver's seat on these vehicles is mounted on a platform attached directly to cab floor. Rider's seat is mounted in same manner as driver's seat.

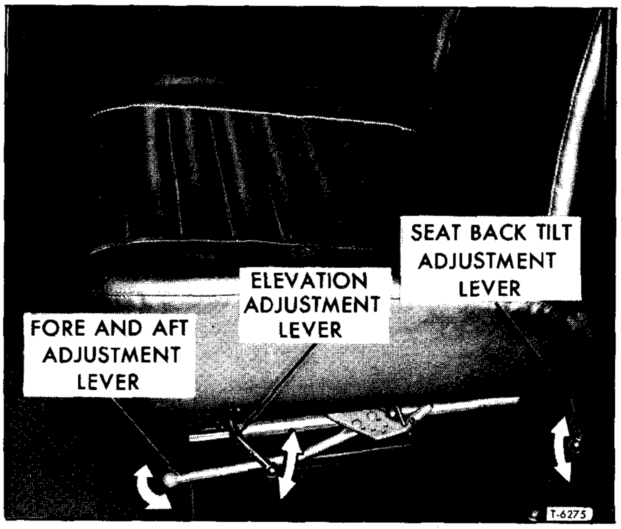

Figure 30—Standard Seat Adjustment

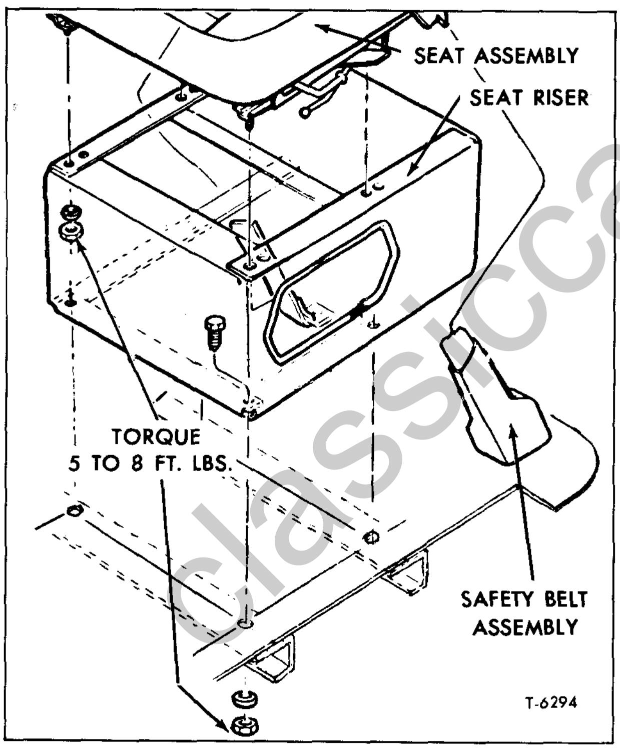

Figure 31—Standard Seat Installation

Standard Seat Adjustment (Fig. 30)

1. To adjust seat forward or backward, push adjustment lever towards rear of cab and slide seat to desired position.

2. To adjust seat height, lift or push down on elevation lever and raise or lower seat to desired position.

3. To adjust seat back, lift or push down on tilt lever and position seat back to desired angle.

Standard Seat Replacement (Fig. 31)

1. Through opening in platform below seat, remove four nuts and washers which retain seat tracks to platform.

2. If necessary, platform may be replaced after removing four bolts at base of platform.

3. Reverse "Removal" procedure to install seat and platform. Tighten seat-to-platform nuts to 5-8 foot-pounds torque and platform-to-floor bolts to 15-20 foot-pounds torque.

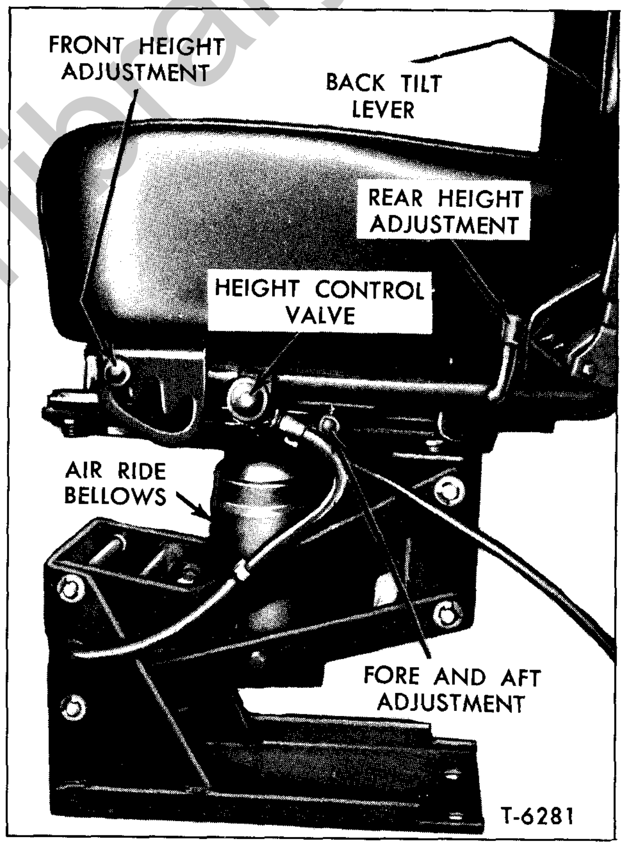

Figure 32—Air Suspended Seat (Typical)

OPTIONAL DRIVER'S SEAT (Fig. 32)

A wide range of optional seats are offered on these vehicles. Instructions for operating these seats are usually shown on a decal located in a prominent place on seat frame or on an instruction tag attached to seat.

Replacement (Fig. 33)

Suspension of optional drivers seats is either of the spring loaded or air type. Bases of these seat suspensions are mounted directly to cab floor and understructure framing. In general, these seats may be replaced as an assembly after removing attaching bolts at base of mounting. For seats with air suspension, the vehicles air supply should be exhausted before attempting to remove air line at seat bellows. When installing seat, mounting bolts should be tightened to 15-20 foot-pounds torque.

LAP BELTS

Clean lap belts with a mild soap solution and lukewarm water. Do not bleach or dye belt fibers as this may cause severe loss of strength.

Periodically inspect belts, buckles, retractors, and anchors for damage that could lessen the effectiveness of the restraint system. If necessary, to replace lap belts or related fasteners, refer to "GENERAL CAB MAINTENANCE" (SEC. 1A) of this manual.

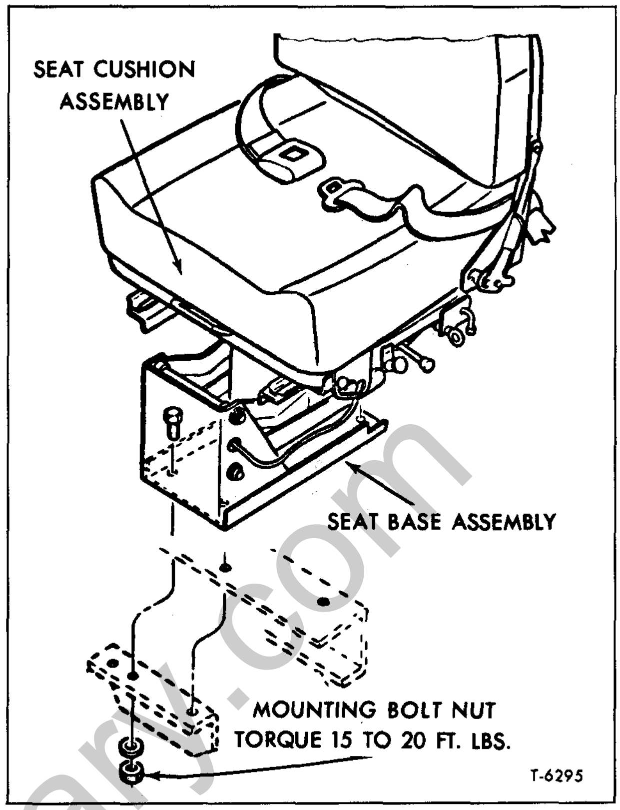

Figure 33—Air Suspension Seat Installation

SLEEPER COMPARTMENT

Titan 90 Series cabs equipped with sleeper compartments are of 74" and 86" BBC dimensions. A two-way fresh air ventilator and heater duct is provided on each side of compartment. Three bunk widths are available and mattresses are of either foam or inner-spring construction. A sleeper compartment curtain is available as optional equipment.

The sleeper compartment is well insulated through use of rigid foam-type material against sleeper compartment outer panels. Over this is a layer of tufflex insulation covered with embossed black vinyl.

MAINTENANCE

Refer to "GENERAL CAB MAINTENANCE" (SEC. 1A) of this publication for information concerning the cleaning of vinyl sleeper compartment interior panels. Also provided are procedures for replacement of rear windows and fresh-air ventilators.

Refer to page 89 in this manual for information pertaining to the operation of the sleeper compartment heater.

Refer to "GENERAL CAB MAINTENANCE" (SEC. 1A) at beginning of this group for applicable information on straightening, dinging, refinishing and painting of cab components.

IMPORTANT

Always wear heavy type gloves to prevent possible injury when handling glass.

MISCELLANEOUS CAB COMPONENTS

FRONT BUMPER

Three types of front bumpers are offered. Standard bumper is painted steel; optional bumpers are chrome finished steel or solid aluminum. Bumpers are formed with air scoop and step holes.

Bumpers are attached to front cab tilting pivot assembly with six (6) bolts (fig. 34). To remove bumpers, place a box-end wrench on bolt head and remove nut and washer at pivot assembly. To prevent damage to bumper finish, DO NOT allow bumper bolts to turn when removing or installing. Tighten bumper bolt nuts to 50-60 foot-pounds torque.

GRILLE AND MOULDING

The grille assembly is of a cross-hatched design constructed of extruded aluminum strips. Surrounding grille is a formed moulding which is clip retained to cab front panel.

GRILLE AND MOULDING REPLACEMENT
(Refer to Figure 35)

1. With aid of an assistant, remove eight grille attaching bolts and then remove grille assembly and inner moulding.
2. Using a flat-bladed tool such as a putty knife, gradually pry outer moulding away from cab front panel. Be careful not to bend moulding or damage cab paint.
3. To install, carefully snap outer moulding and clip retainers in place. Position inner moulding on grille assembly. Center grille assembly in cab opening and install attaching bolts.

SERVICE DOORS

Two identical hinge-mounted engine service doors are located at front of cab. One door allows access to radiator filler; the other provides access to engine oil dipstick and engine oil filler tube.

Each door may be removed by removing three (3) hinge attaching screws (fig. 36). When installing attaching screws, center door in opening and tighten screws snugly. If magnetic catch was removed, be sure to position contact surface of magnet 90 degrees to door and tighten attaching screw firmly.

STEP ASSEMBLY

A stirrup-type step assembly is provided on each side of cab. Step is bracket-retained beneath cab above wheel opening (fig. 37). To replace, remove four bolts that attach each bracket to step assembly. Remove both brackets and step assembly from cab.

Reverse removal procedure to install step assembly. Tighten attaching bolts to 8-12 foot-pounds torque.

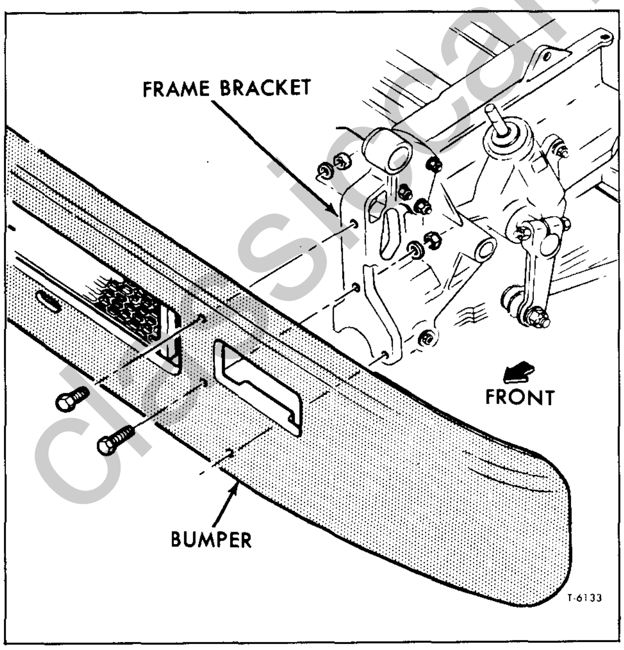

Figure 34—Front Bumper Installation

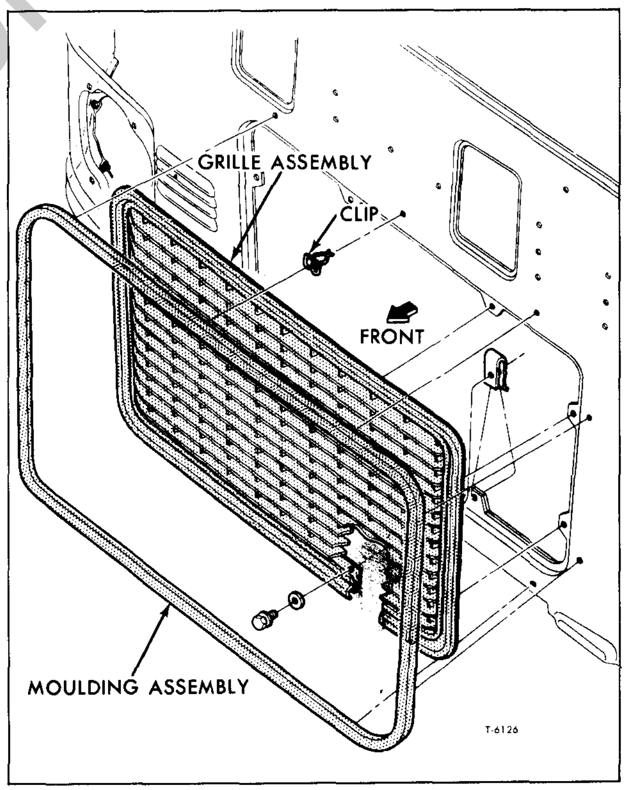

Figure 35—Grille Installation

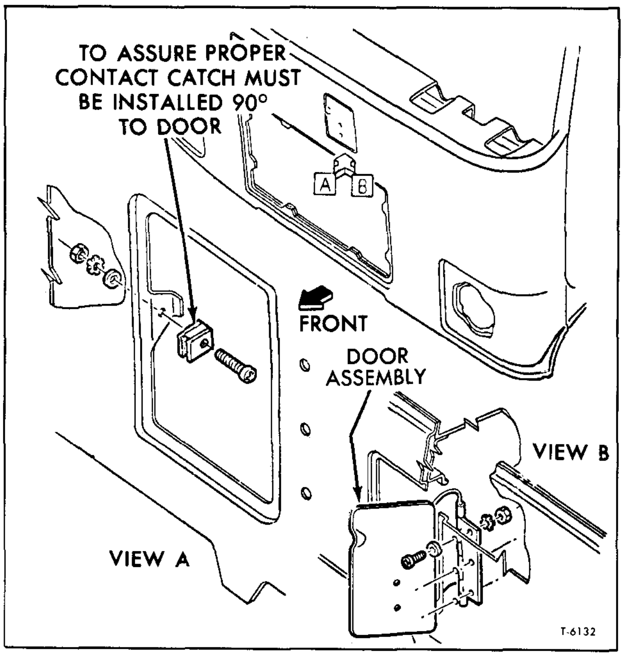

Figure 36—Service Door Installation

FENDERS

The front fender or splash guard assembly is constructed of moulded vinyl material. The fender is attached to cab wheel openings with formed metal retainers (fig. 38). Fender may be more readily accessible for removal if cab is tilted forward slightly.

1. Remove step assembly as described previously.
2. Remove bolts, nuts, and washers which attach main and corner retainers to bottom of cab.
3. Remove retainers and vinyl fender from cab.
4. Reverse removal procedure to install fender. Tighten all attaching bolts and nuts firmly.

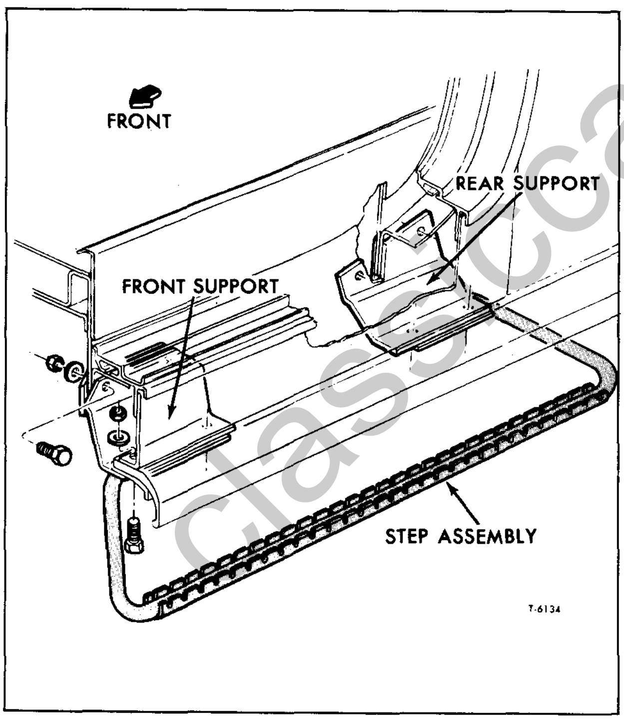

Figure 37—Cab Step Assist Installation

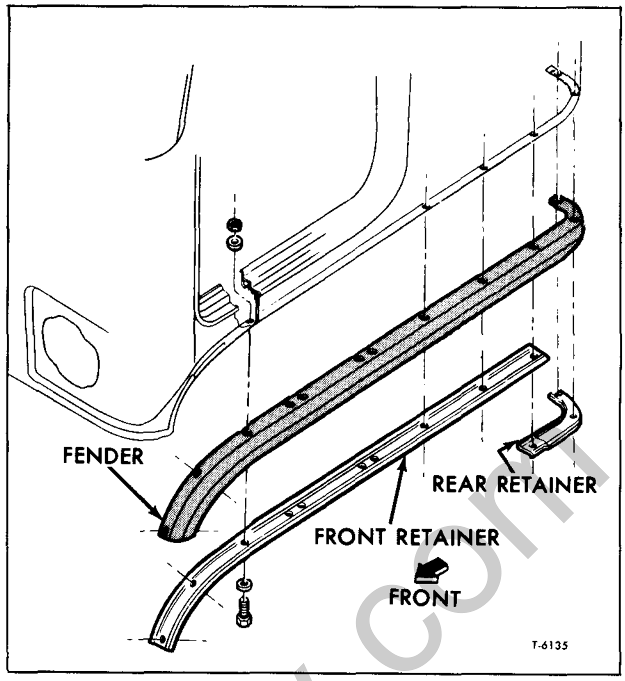

Figure 38—Fender Installation

OUTSIDE MIRRORS

Two types of side mirrors are offered. The left view of figure 39 illustrates the 6" x 16" west-coast type; the right view illustrates the coach-type.

WEST-COAST TYPE MIRROR (Fig. 39)

The west-coast type mirror is bracket-mounted to each entrance door. No periodic maintenance is required other than an occasional tightening of the bracket-to-door screws to assure a firm mounting. Two bolts which attach mirror housing arms to brackets should be maintained at 25-30 foot-pounds torque. Should mirror breakage occur, the mirror housing and mirror should be replaced as an assembly.

COACH-TYPE MIRROR (Fig. 39)

A coach-type mirror is bracket-mounted to each front corner panel. Mirror and arm assembly

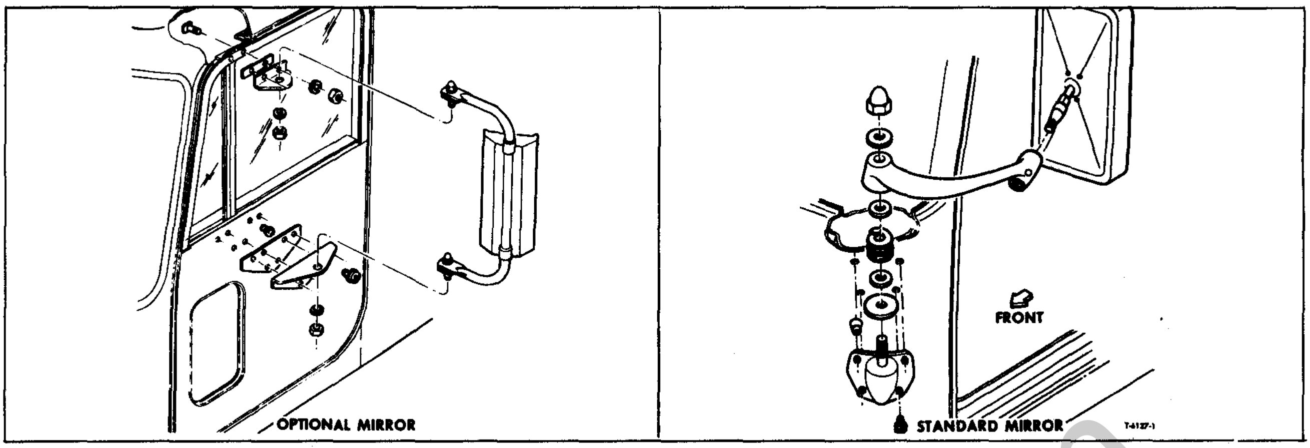

Figure 39—Outside Mirror Installation

may be detached by removing acorn nut from bracket assembly stud. Upon installation, lightly coat large washer between spring and mounting bracket with a water repellent grease. Tighten acorn nut to 30-40 foot-pounds torque.

Mirror Replacement

The mirror can be replaced if broken. Proceed as follows:

1. Carefully pry rubber moulding from mirror head. Remove screws which attach mirror retainer to head.
2. Wearing gloves, remove broken glass from mirror head.
3. Apply mastic to edge of mirror glass, position mirror on head and install retainer. Replace rubber moulding around head.

Head Tension Adjustment

By loosening wing-nut on head end of arm, mirror head ball stud may be repositioned in mounting as required.

LUGGAGE COMPARTMENT DOOR

Vehicles equipped with a sleeper compartment are equipped with two luggage compartments, one at each side of cab immediately behind cab entrance door (fig. 40). Luggage compartment door is piano-hinged to cab opening. Door latch is a spring-loaded device that is released from inside cab.

DOOR AND SEAL REPLACEMENT (Fig. 40)

1. Remove hinge attaching bolts and remove door.

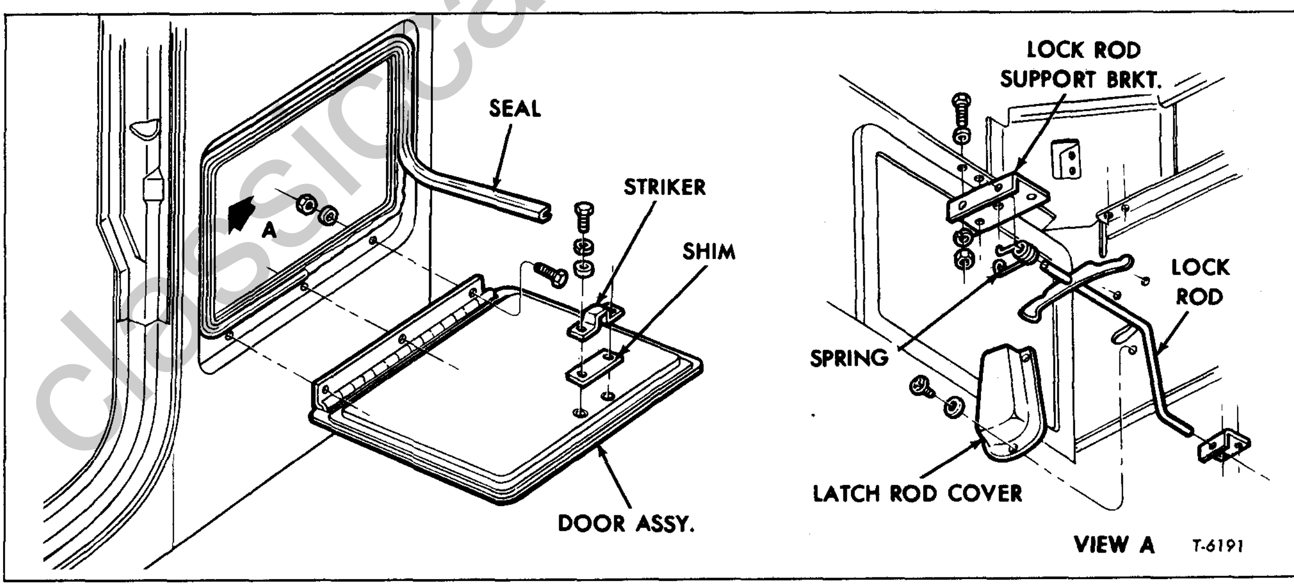

Figure 40—Luggage Compartment Door Installation

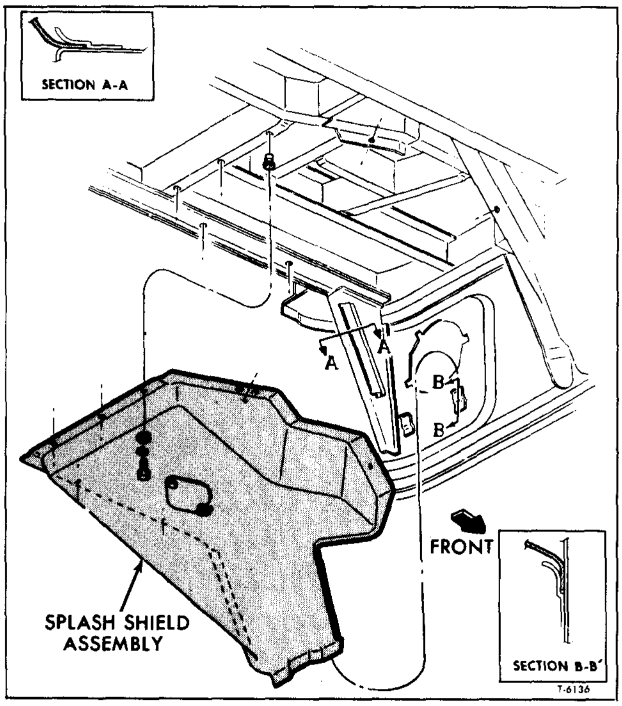

Figure 41–Splash Shield Installation

2. Remove door striker attaching bolts and then separate striker and shim from door.

3. Starting at bottom of luggage compartment opening, lift and carefully pull seal from opening. Remove old adhesive and check flange for irregularities.

4. Apply even bead of adhesive on flange around entire perimeter of compartment opening. Starting at top of cab opening, install new seal over flange, pressing it evenly into corners. Cut seal to allow sufficient overlap and then butt ends at bottom of compartment opening.

5. Attach shim and striker to door. Torque attaching bolts to 8-15 foot-pounds.

6. Install compartment door to cab opening. Be sure door is centered in opening before final tightening hinge attaching bolts to 8-15 foot-pounds torque.

DOOR LATCH REPLACEMENT (Fig. 40)

1. From inside luggage compartment, remove three screws which retain latch rod cover to front panel.

2. Remove nuts that retain latch rod brackets to compartment ceiling. Remove latch rod and bracket assembly from compartment.

3. Reverse the removal procedure to install. Tighten bracket attaching bolts to 8-15 foot-pounds torque.

SPLASH SHIELD

The fiberglass splash shield, located beneath left side of cab, is provided to protect brake application valve, air lines, steering and clutch linkage from road splash. An inspection plate is provided in splash shield which may be opened to gain access to clutch cross-shaft grease fitting.

REPLACEMENT (Fig. 41)

The splash shield is bolt and lip retained to cab understructure. To remove, tilt cab and remove seven attaching bolts. Lift shield up from sheet metal lips and remove from beneath cab.

Reverse removal procedure to install. Be sure lips at edge of shield are engaged and attaching bolts are tightened securely.

HEATING SYSTEM

DESCRIPTION

The cab heating system is an integral unit designed to provide driver comfort by heating and/or circulating air through the cab. For cabs equipped with a sleeper compartment, an auxiliary heater is provided.

Heater core is located inside main heater housing (fig. 42) which is positioned in center console of cab. The sleeper heater core assembly is attached to left rear side of main heater housing.

The blower and air inlet assembly, attached below main heater housing on passenger's side of console is equipped with two blower motors. The blowers circulate air through the main heater core, the sleeper heater core (if equipped), and into air ducts.

The dual blower motors, which are electrically connected in parallel, are fed from a four-position control switch and resistor network. All blower electrical circuits are protected by an automatic reset circuit breaker. Refer to master wiring diagram on center console access cover when troubleshooting heater electrical circuits.

IMPORTANT: Before attempting to remove any electrical component, be sure to pull out reset button on master circuit breaker to allow service to heater wiring without danger of shorting out. A white ring around base of button is visible when master circuit breaker is open.

AIR CIRCULATION (Fig. 42)

Outside air enters heating system through a louvered opening located on vehicle front panel between right headlight and grille. Air flow then passes beneath cab floor through an air intake duct into the blower and air inlet assembly. From the blowers, air is forced into the main heater housing, air distributor assembly, and out through heater and defroster ducts. If cab is equipped with sleeper compartment, air from blowers is also directed through the sleeper heater core into ducts that lead to rear corner outlets in sleeper compartment.

Volume of outside air entering heating system is controlled by a damper valve positioned at entrance of blower housing assembly.

NOTE: Operation of individual heater controls is described in "Operating Instructions" later in this section.

COOLANT CIRCULATION (Fig. 43)

Engine coolant is force-circulated through heater core(s) as a result of pressure from engine water pump. For the standard cab, hot coolant from bottom of water filter flows through a flexible hose into main heater core and is returned to connection at top of water filter. For sleeper compartment cabs, the coolant leaves the main heater core and passes through the sleeper heater core before being returned to the engine (fig. 44). The flow of coolant through main heater core supply line is controlled by a water valve when vehicle is equipped with air conditioning.

OPERATION INSTRUCTIONS

(Refer to Figure 42)

The heating system is controlled by three levers and a four-position fan switch. All controls are located on the console to the right of the gauge panel.

WARNING-CARBON MONOXIDE

To keep out offensive odors and exhaust gases when in congested traffic, or parked behind a vehicle with its motor running, close outside air intake ventilators. An outside air intake is used with heater. Close this intake to minimize introduction of contaminated air into cab; this is accomplished by moving "AIR" lever on heater control panel to "RECIR." position. Avoid inhaling exhaust gases when any concentration of these is present in the air; i.e., in a garage or when parked for extended periods with engine running. Exhaust gases have strong odors which normally should give warning of their presence. However, the exhaust gases from some vehicles may not be so noticeable under certain conditions and the senses of people react differently. Exhaust gases contain a percentage of carbon monoxide which is a poisonous gas that, by itself, is tasteless, colorless, and odorless.

1. The "AIR" lever controls the source of air through system. Push knob up for outside air; push knob down to recirculate inside air. Intermediate positions of lever will result in a proportional mixture of outside and recirculated air flow through system.

2. The "HTR" lever controls the direction of air flow from system. Push knob up to direct air flow through heater outlets; push knob down to direct air flow through defroster outlets. Intermediate positions of lever will result in proportional amounts of air flow through both heater and defroster outlets.

3. The "TEMP" lever directs air flow either around or through the main heater core, or through

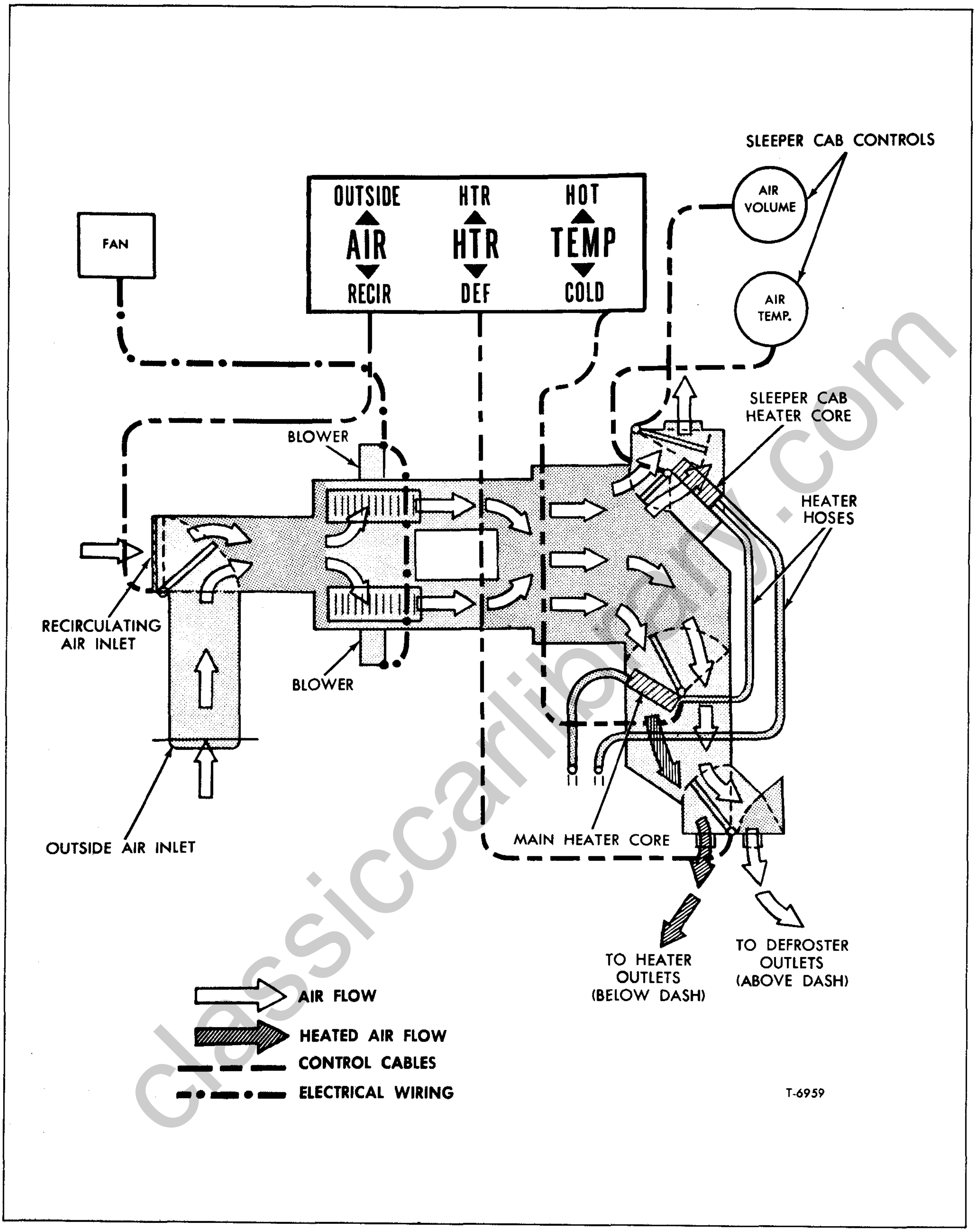

Figure 42—Heater Air Flow and Control Schematic

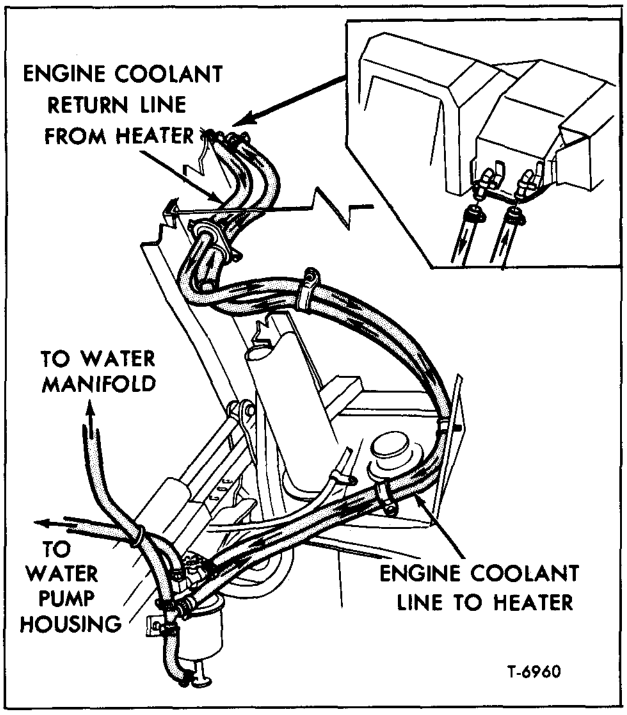

Figure 43—Engine Coolant Circulation to Heater

both. Lever may be set at any position between "COOL" and "HOT" to control temperature of air circulated through cab. If air directed through heater ducts to cab floor is desired, move "HTR" knob part way between "HTR" and "DEF."

4. The "FAN" switch controls the speed of the blower motors. The four switch positions are "OFF" (lever down), "LOW." "MEDIUM," and "HIGH" (lever up). The blower is used to move air for the heater, defroster, sleeper compartment heater, and air conditioning system.

The exhaust system should be inspected for leaks and missing or damaged parts each time the vehicle is lubricated.

OPERATING HEATING SYSTEM

1. For heating only, move "AIR" lever to "OUTSIDE." Position "TEMP" lever as required for comfortable temperature of incoming cab air.

2. Should defogging of windshield be required, open fresh air ventilator door slightly, place "HTR" lever to "DEF" and operate blower at high speed.

3. For warm weather ventilation, less air conditioning, place "AIR" lever on "OUTSIDE," "HTR" lever on "HTR," "TEMP" lever on "COLD," and then place blower switch on High Speed. Air flow will be directed through heater outlets.

SLEEPER CAB HEATER

Models with a sleeper cab have an auxiliary heating system. There are two controls for operating this system. The control knobs are located

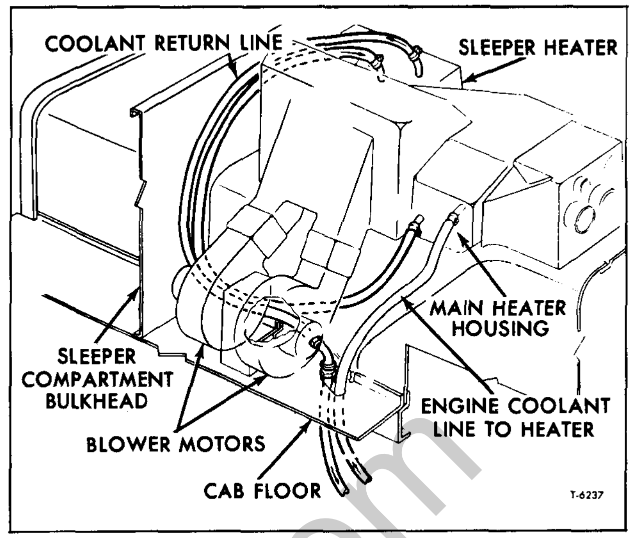

Figure 44—Sleeper Heater Coolant Flow

to the right of the driver, rearward of the main heating and air conditioning control panel on the console. One knob controls the volume of air flow into the sleeper compartment and the other controls the temperature of the air. For greater volume and/or higher temperature, pull knobs out. For less volume and/or lower temperature, push knobs in.

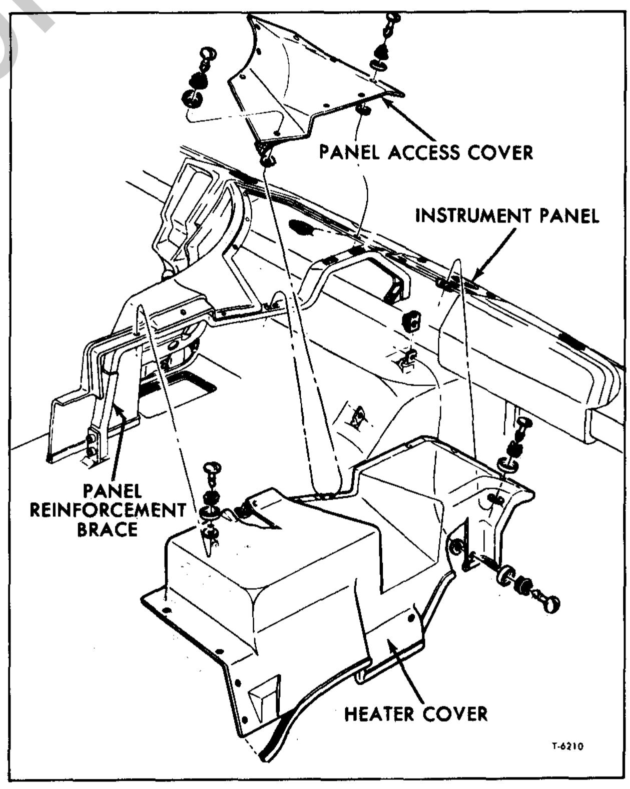

Figure 45—Console Access Panels

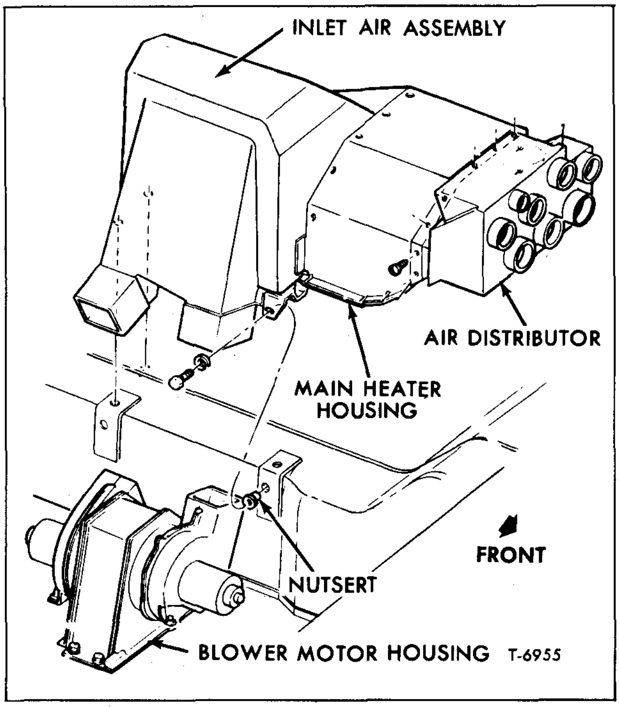

Figure 46—Blower Motor Assembly, Main Heater Housing, and Air Distributor Assembly

ON-VEHICLE SERVICE

CONSOLE ACCESS PANEL AND HEATER COVER REPLACEMENT (Fig. 45)

1. Remove passenger seat and platform (when used).

2. Loosen quick release screws that retain panel access cover to panel reinforcement brace, console panel, and heater cover. Remove access cover from cab.

3. Loosen quick release screws retaining heater cover to panel reinforcement and console panel. Remove heater cover from cab.

4. To install covers simply reverse removal procedures. Be sure seals located on edges of access panel and heater covers are in place before tightening quick release screws.

INLET AIR ASSEMBLY, MAIN HEATER HOUSING, AND AIR DISTRIBUTOR (Refer to Figs. 42 and 46)

Removal

1. Remove access panel and heater cover as described previously in this section, under "Console Access Panel and Heater Cover Replacement."
2. Drain the engine coolant.
3. Disconnect battery ground cable.
4. Disconnect coolant lines from main heater core and sleeper heater core (when used).
5. Disconnect electrical leads from blower motors and air conditioning switch, mounted on air distributor. Then move wiring harness out of position so as not to interfere with heater housing removal.
6. Disconnect all heating and cooling control cables. Label each with colored tape to assure proper installation.
7. On models equipped with sleeper compartment heater, lift up mattress and plywood support, then loosen plastic clamps retaining sleeper ducts to sleeper heater outlets. Note that plastic clamps are located immediately to the rear of sleeper compartment bulkhead.
8. Loosen plastic clamps retaining heater and defroster duct hoses to air distributor assembly. Remove air conditioning outlets from air distributor.
9. Remove bolts that retain main heater housing and sleeper heater (when used) to engine tunnel.
10. Visually inspect to determine if other equipment, lines, cables, brackets, or attaching parts must be removed to permit removal of the main heater housing and air distributor assembly.

NOTE: It may be necessary to loosen screws at both ends of panel reinforcement brace to provide additional clearance for removal of main heater housing and air distributor assembly (refer to fig.45).

11. With the aid of an assistant, carefully remove inlet air assembly, main heater housing and air distributor, plus sleeper heater (when used) from inside cab.

12. If desired, air distributor and sleeper heater can be removed from main heater housing. If air distributor is removed from main heater housing during assembly, use a sealer at the mating surfaces between the two components to prevent air leaks.

Installation

1. With the aid of an assistant, carefully position inlet air assembly, main heater housing and air distributor assembly in the cab on the engine tunnel.

2. Install bolts that retain inlet air assembly and sleeper heater (when used) to engine cover.

3. Attach heater and defroster hoses to air distributor. Retain hoses in position with plastic clamps.

4. On models equipped with sleeper compartment heater, lift up mattress and plywood support, then secure sleeper ducts to sleeper heater outlets with plastic clamps.

5. Connect all heating and cooling control cables (refer to fig. 42).

NOTE: Each control cable is equipped with a threaded sleeve which can be adjusted to assure proper cable operation.

6. Connect electrical leads to air conditioning switch mounted on air distributor and blower motors
7. Attach coolant lines to main heater core and sleeper heater core (when used).
8. Connect battery ground cable.
9. Install access panel and heater cover as described previously in this section.

BLOWER MOTORS

Removal

NOTE: The blower motor assembly is composed of two blower motors and blower motor housing. Front blower motor may be removed by simply separating from blower motor housing. Remove blower motor assembly as follows:

1. Disconnect battery ground cable.
2. Remove passenger seat and platform (if so equipped).
3. Remove four bolts (from underside of cab) which retain blower motor assembly to cab floor.
4. Disconnect electrical leads from blower motors.
5. Remove remaining bolts retaining blower motor assembly to cab floor.
6. Carefully remove blower motor assembly from vehicle.

Installation

1. Place blower motor assembly in cab so that air outlets engage rubber connections on main heater housing.
2. Install bolts retaining blower motor assembly to cab floor. Note that four bolts must be installed from underside of cab.
3. Connect electrical leads to blower motors.
4. Install passenger seat and platform (if so equipped).
5. Connect battery ground cable.
6. Check operation of blower motors.

HEATER CORE

Removal (Refer to Figs. 46 and 47)

1. Disconnect battery ground cable.
2. Remove access panel and heater cover as described previously in this section, under "Console Access Panel and Heater Cover Replacement."
3. Drain and disconnect coolant lines from main heater housing.
4. Disconnect all control cables and electrical leads which would interfere with removal of main heater housing. Label each with colored tape to assure proper installation.
5. Remove screws attaching main heater housing to inlet air assembly and air distributor.

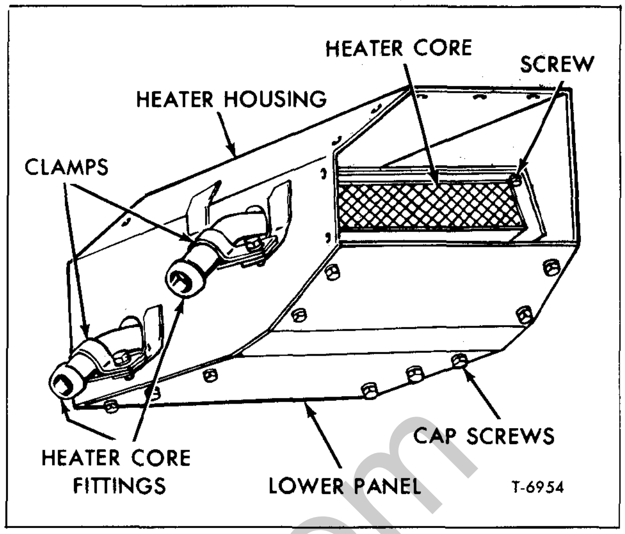

Figure 47—Main Heater Housing

6. Carefully separate air distributor from main heater housing, then slide air distributor (with air hoses connected) toward front of vehicle, sufficiently to allow removal of main heater housing.
7. Separate main heater housing from inlet air assembly and carefully remove main heater housing from vehicle.
8. With main heater housing removed from vehicle, referring to figure 47, perform the following steps to remove heater core:
   a. Remove cap screws retaining lower panel to heater housing, then remove lower panel.
   b. Remove clamps securing heater core fittings to heater housing.
   c. Remove screws securing heater core to heater housing, then remove heater core.

Installation (Refer to Figs. 46 and 47)

1. Position new seals on heater core fittings, and slide up against heater core.
2. Place heater core in heater housing and secure with four screws. Attach clamps to heater core fittings.
3. Position seals on lower panel. Secure lower panel to heater housing with cap screws.
4. Position main heater housing in vehicle between the inlet air assembly and the air distributor. Secure main heater housing to air inlet assembly with attaching screws.
5. Apply a light coating of sealer to overlapping surfaces of main heater housing and air distributor. Secure air distributor to main heater housing with attaching screws.

NOTE: Sealer is used between main heater housing and air distributor to eliminate the possibility of air leaks in heater system.

6. Connect coolant lines, control cables, and electrical leads, which were removed to facilitate heater core removal. Refill cooling system.

7. Connect battery ground cable.

8. Check operation of heating system.

9. Install access panel and heater cover as described previously in this section, under "Console Access Panel and Heater Cover Replacement."

WARNING

Never sleep in cab unless adequate ventilation is provided.

BODY MOUNTINGS

PLATFORM BODY MOUNTINGS

Before any body mounting is attempted, this section should be studied carefully and the recommendations followed as closely as possible.

When mounting bodies, certain important procedures should be followed. Unless such practices are followed, strains of load and chassis weave may not be distributed correctly, causing damage to body or frame.

IMPORTANT: Avoid drilling additional holes in frame for mounting bolts. Use existing holes if possible; if additional holes are necessary, close unused holes by welding.

LONGITUDINAL SILL MOUNTING

If body is equipped with longitudinal sills, observe following standard practices.

1. Wooden longitudinal sill should rest directly on top flange of chassis frame side rail. If projecting rivet heads prevent a solid bearing, countersink longitudinal sills just enough to clear rivet heads.

IMPORTANT: Do not use spacers to raise sills above rivet heads. If body longitudinal sill is of metal, it will be necessary to use a one-piece full length hardwood strip, with holes to clear rivet heads between body sill and frame rail. Wood strip should be firmly fastened to body sill.

2. Sill should extend as close as possible to back of cab without interfering with mounting or movement of cab.

3. Make sure height of sill is sufficient to prevent body from striking tires, or other parts of chassis, with maximum spring deflection. Take into consideration full load operation over extremely rough terrain.

4. Sill must rest squarely on frame flange and not overhang outside of frame. If sill width does not cover entire width of frame, install a spacer block as shown in figures 1 and 2. Blocks should

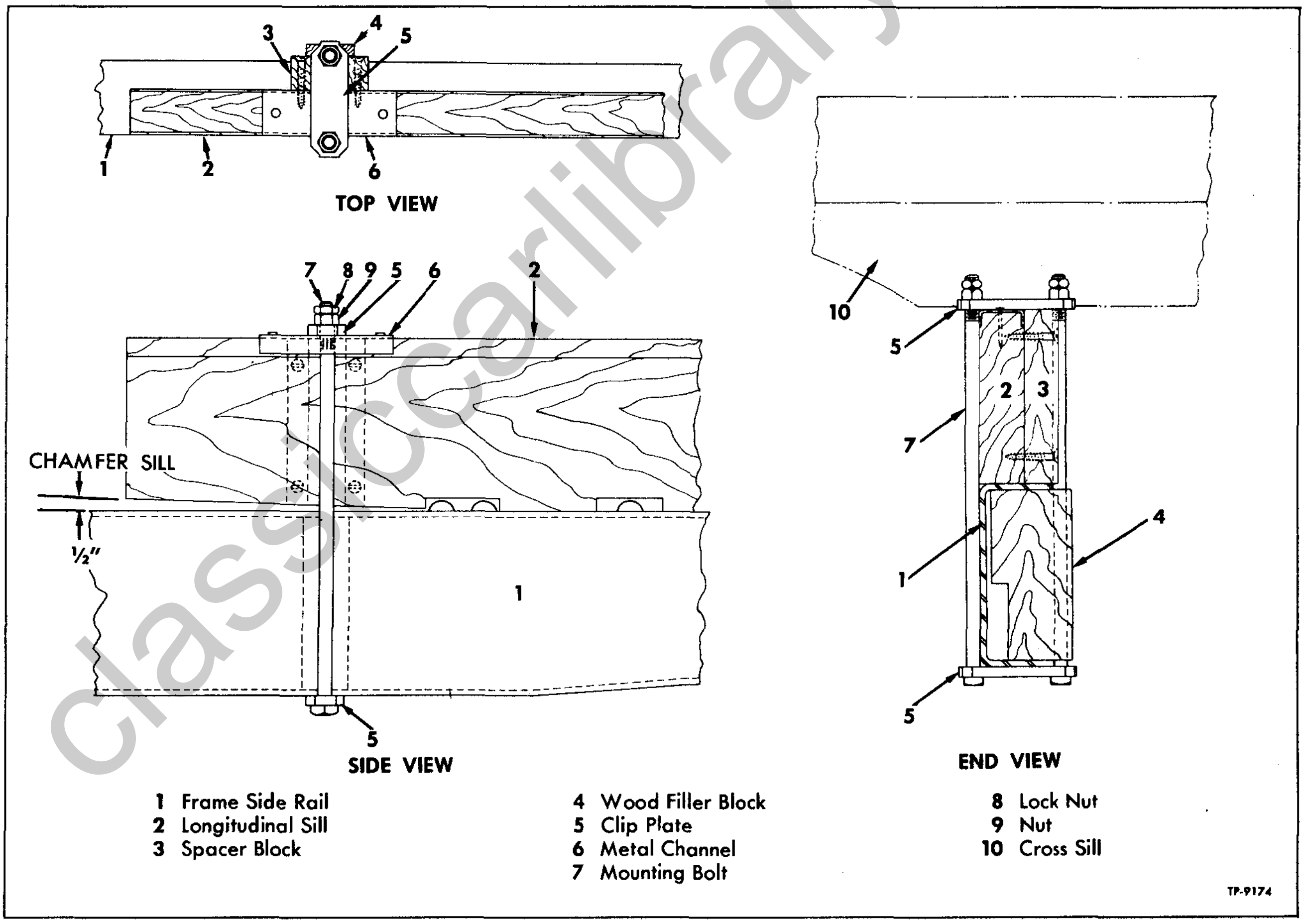

Figure 1—Typical Body Mountings

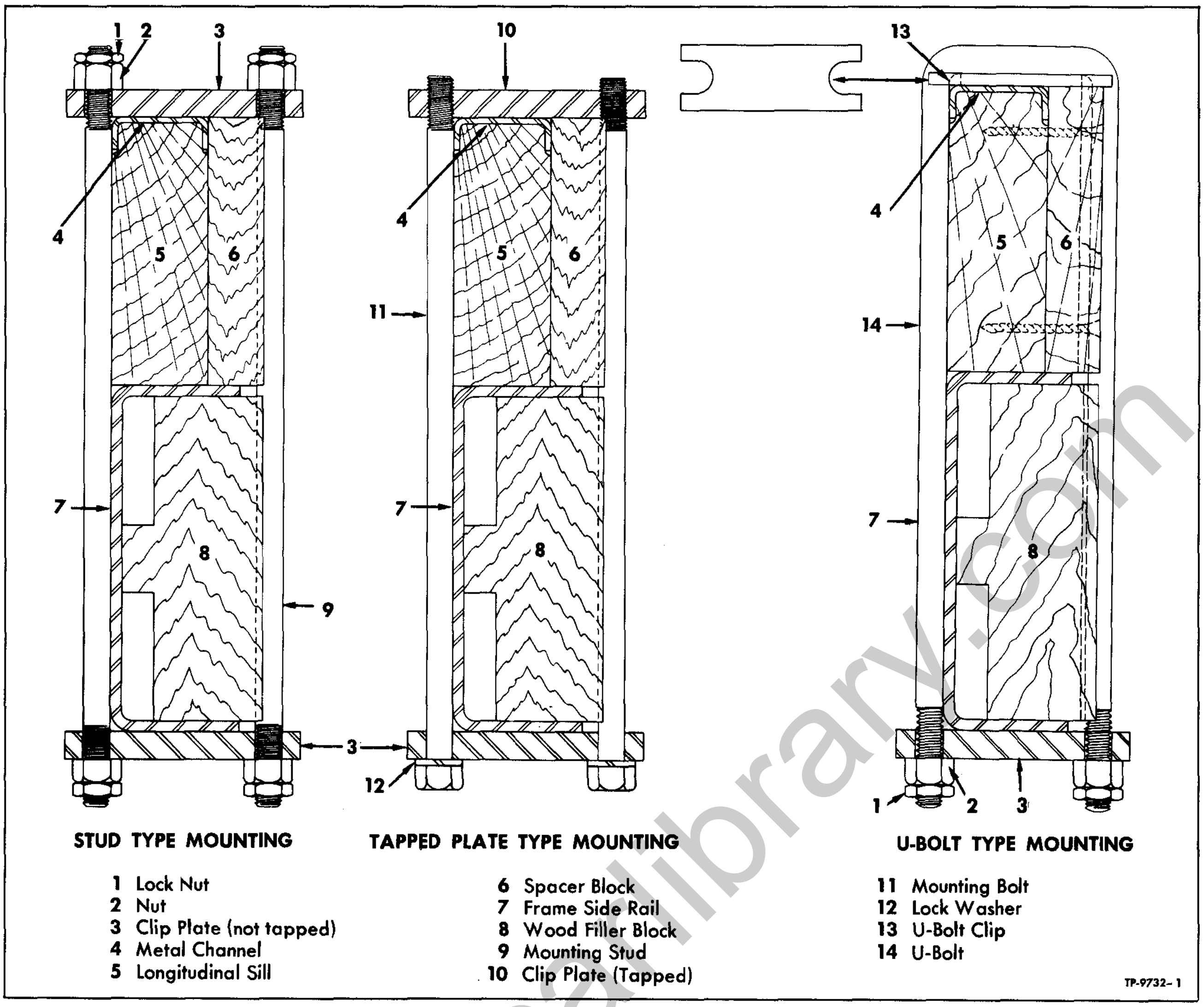

Figure 2—Recommended Methods of Mounting Body

extend beyond width of frame flanges to permit grooving blocks to maintain position of mounting bolts. If desired, block can be attached to sill with screws as shown in figure 2.

Wood grain of block should be perpendicular (up and down) to grain of sill.

5. Wood sills must be chamfered 1/2" at the front end, tapering to meet the frame 12 to 18 inches from end of sill (fig. 1). Tapered front of sill is required for all Van or torsionally rigid bodies. Notch or spot drill sill to clear the rivet heads.

6. To prevent mounting clip plate becoming embedded in longitudinal sill, install a sheet metal channel on top of sill at each mounting point (figs. 1, 2, and 3). Rabbet grooves along each side of top edges of longitudinal sills to permit flush mounting of sill channels.

MOUNTING BOLTS

1. Install one mounting near front end of sill, one near rear end of sill, and space others as nearly equal as possible between front and rear mountings. It may be necessary to vary distances to clear chassis brackets, etc., but approximately equal spacing should be maintained.

2. Use two bolts or studs of proper length with a diameter of at least 7/16" and preferably 1/2" for each mounting. Use a clip plate, of same thickness as diameter of bolts, at upper and lower end of bolts. Use at least three, and preferably four mountings on each side.

3. Hex head bolts are preferred for body mountings; however, carriage bolts, U-bolts, and threaded rods (studs) can also be successfully employed. If design of body does not permit use

of nuts at top of sill, tapped plate, as shown in figure 2 can be used.

4. Insert a block of hard, dry wood (with grain running up and down) in channel of frame at each mounting. Block must be of sufficient length to extend well under clip plates. Thickness of block should extend beyond width of frame flanges to permit grooving the blocks. Inner mounting bolt will fit into groove and hold block firmly in place (fig. 1 or 2).

5. If shoulder on bolt head is square, as on carriage bolts, the holes in upper clip plates should also be square. Shoulder of bolts should be driven into holes to prevent bolts turning. If U-bolts are used, bolt must be of "flatted" type as shown in figure 2. A clip or spreader must be used on each U-bolt, and bolt must not be used in reverse of position shown in figure 2.

6. Use two nuts on threaded end of each bolt. Tighten inner nut firmly, then tighten outer (lock) nut firmly against inner nut. DO NOT USE SINGLE NUT AND LOCK WASHER. However, lock washer should be used with tapped plate type of mounting.

CROSS SILL MOUNTING

If body is not equipped with longitudinal sills, attach sills, if possible, as shown in figure 3, since mounting on cross sills (bolsters) is not recommended. Longitudinal sills can be easily made of dry hardwood and attached to either wood or metal cross sills by means of angle irons and bolts. General practice of body mounting is on longitudinal sills; however, where the conditions necessitate mounting directly on cross sills, the following practices should be observed:

1. Sills must rest squarely on frame top flange. Countersink sill, if necessary, to clear rivet heads -- do not use spacer.

2. Use same type of mounting bolts and clip plates as described in "Mounting Bolts." The number of clips to use is of course dependent upon load, body style, etc. Carriage or step bolts are useful in this type mounting, since bolt heads project above floor.

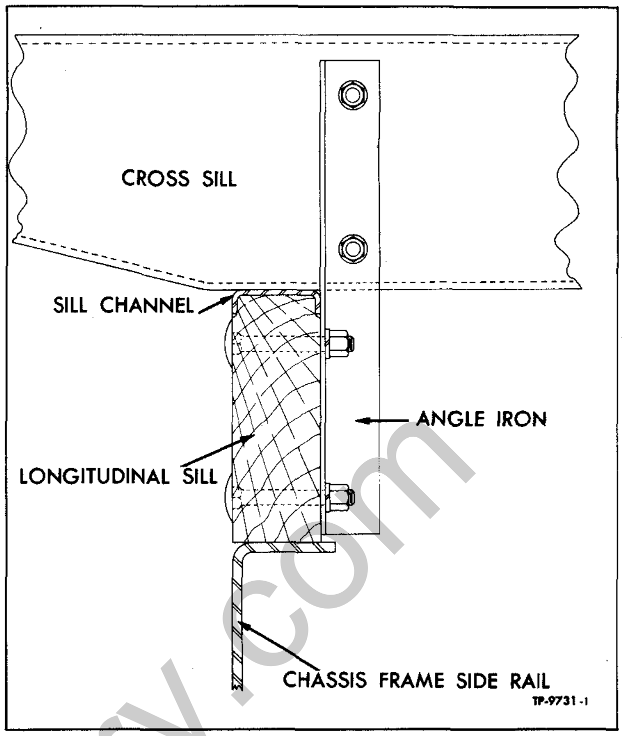

Figure 3—Method of Attaching Longitudinal Sills to Body

3. Use wood blocks in frame channel whenever mountings are used on frame. Mount clip plates diagonally across frame rail -- with one bolt forward of cross sill and inside frame rail and other bolt to rear of cross sill and outside frame rail.

4. U-bolts cannot be used with this type of mounting since mounting bolts, of necessity, project through floor or platform of body. Make sure that heads of bolts are well supported at body floor with plates or washers.

IMPORTANT

DO NOT drill additional holes in frame.

DO NOT weld heat-treated frame.

Refer to FRAME (SEC. 2) for additional cautions.

AIR CONDITIONING

(INCLUDES HEATING SYSTEM)

Contents of this section are listed in Index below:

GENERAL INFORMATION

INTRODUCTION

The cab heating and optional air conditioning system is an integral unit designed to provide driver comfort by heating or cooling, dehumidifying, and filtering the air circulated through the cab. Blowers in main system assure ample air circulation to assure complete driver comfort in both hot and cold weather. Figures 1 and 2 show typical arrangement of system units in conventional and aluminum cab models.

HEATING SYSTEM

Refer to "ALUMINUM TILT CABS" (SEC. 1D) or "CONVENTIONAL CABS" (SEC. 1B) of this manual for information on standard heating system.

CONDENSING SYSTEM (Fig. 3)

This system is comprised of three major components: the compressor, the condenser, and the receiver-dehydrator unit.

The six-cylinder axial type compressor is belt-driven through electromagnetic pulley-clutch assembly. The compressor pumps refrigerant when the compressor clutch coil is energized.

The compressor with clutch assembly is mounted toward front of engine parallel to the engine crankshaft.

The condenser is a fin and tube-type core designed to change high pressure refrigerant vapor to a liquid due to heat removal. The condenser is mounted in front of engine radiator where it receives a high volume of air due to vehicle movement and engine fan.

The receiver-dehydrator, bracket mounted to right side of radiator shell or sheet metal, is designed to store liquid refrigerant and to remove small traces of moisture that may be in system after purging and evacuating. A sight glass at top of this component is used to observe flow of liquid refrigerant in system.

COOLING SYSTEM (Fig. 3)

This system consists of three major components; the evaporator core, the refrigerant expansion valve, and the P.O.A. (pilot, operated, absolute) valve, on aluminum tilt models, or on conventional models (suction throttling valve).

The evaporator core, located inside main heater housing, works in conjunction with the heater core to provide conditioned air entering cab (see figs. 4 and 5). Refrigerant enters the evaporator as a low-pressure mixture of liquid and vapor. The liquid vaporizes at this low pressure, absorbing large quantities of heat from air that is forced through the evaporator core fins. Thus, air directed into the cab from the evaporator will be cooled (figs. 4 and 5). Also, moisture in air that passes through the evaporator condenses on fins and is drained off carrying away dust and pollen.

The refrigerant expansion valve, located behind main heater housing in the liquid line of the evaporator inlet or below evaporator coil, automatically regulates the flow of liquid refrigerant into the evaporator core.

The P.O.A. valve, mounted beside main heater housing, and attached to outlet line of evaporator (on aluminum tilt cab models) is hermetically sealed and is replaceable only as an assembly. The P.O.A. valve is designed to prevent water condensate from freezing on the evaporator core and provides maximum cooling efficiency by maintaining a predetermined minimum refrigerant

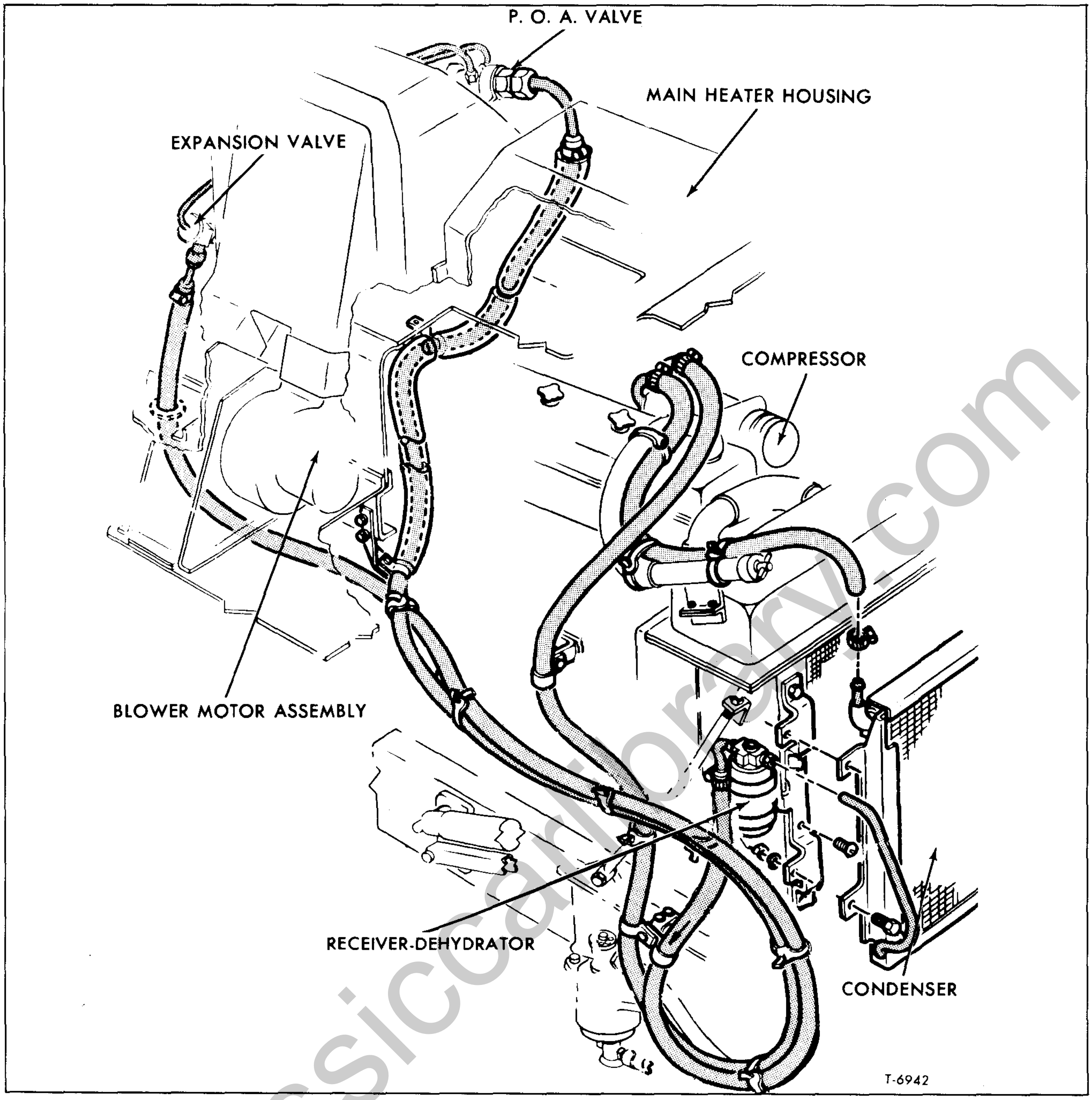

Figure 1—Air Conditioning Lines and Hoses (Typical for Aluminum Tilt Cab Model)

pressure in the evaporator core regardless of variations in the evaporator load or compressor speed.

The suction throttling valve (S.T.V.) on conventional cab models is mounted at top of evaporator housing and is accessible after opening the dash compartment door.

NOTE: Refer to "Insufficient Cooling and Diagnosis Chart" at the end of this section for troubleshooting the systems.

AIR CIRCULATION (Figs. 4 and 5)

Outside air enters system through a louvered opening located on vehicle front panel or side cowl opening. Air flows through an air duct into the blower and air inlet assembly. From the blowers, air is forced into the main heater housing, air distributor assembly, and out through heater and defroster ducts. If cab is equipped with sleeper compartment, air from blowers is also directed through the sleeper heater core into ducts that lead to rear corner outlets in sleeper compartment.

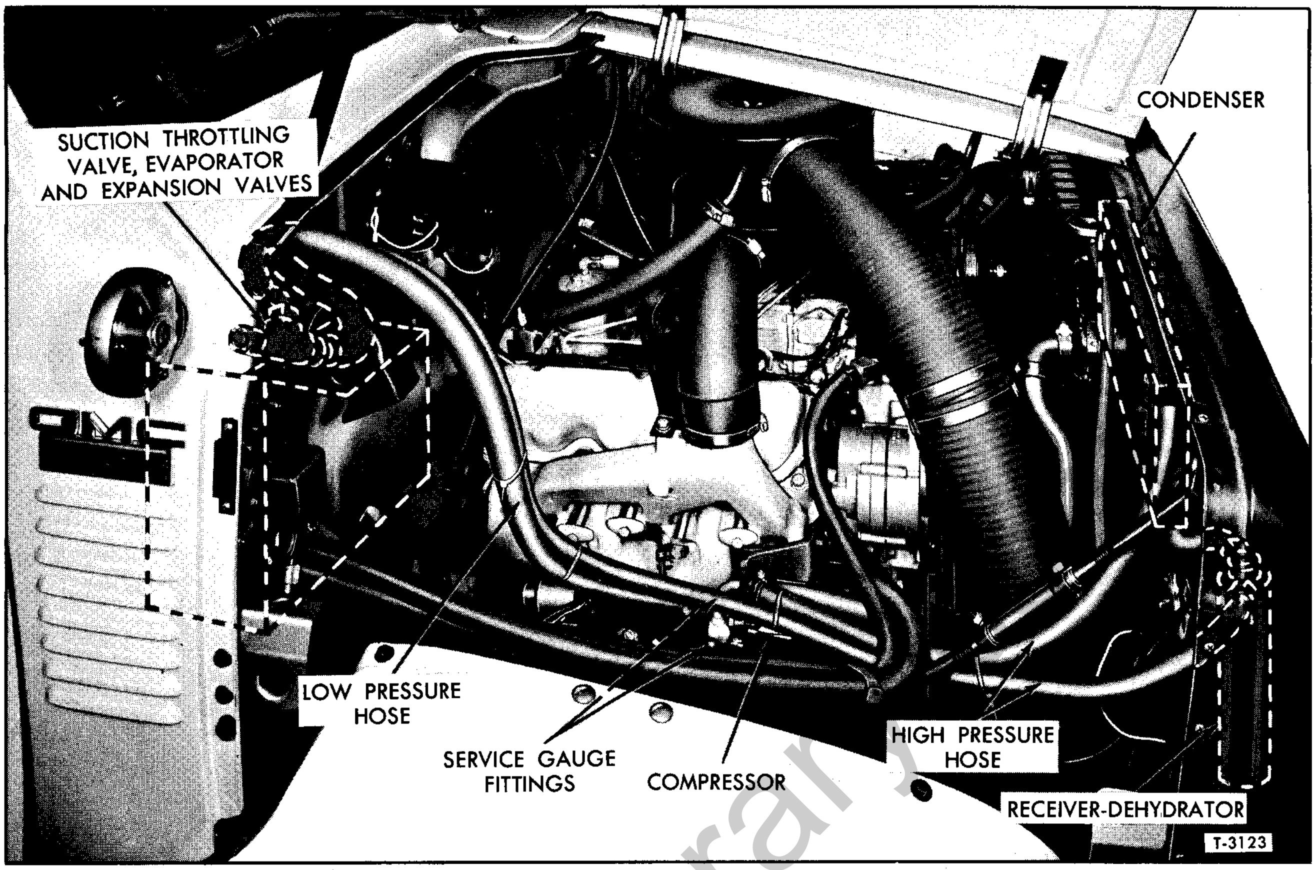

Figure 2—Air Conditioning Lines and Hoses (Typical for Conventional Cab Model)

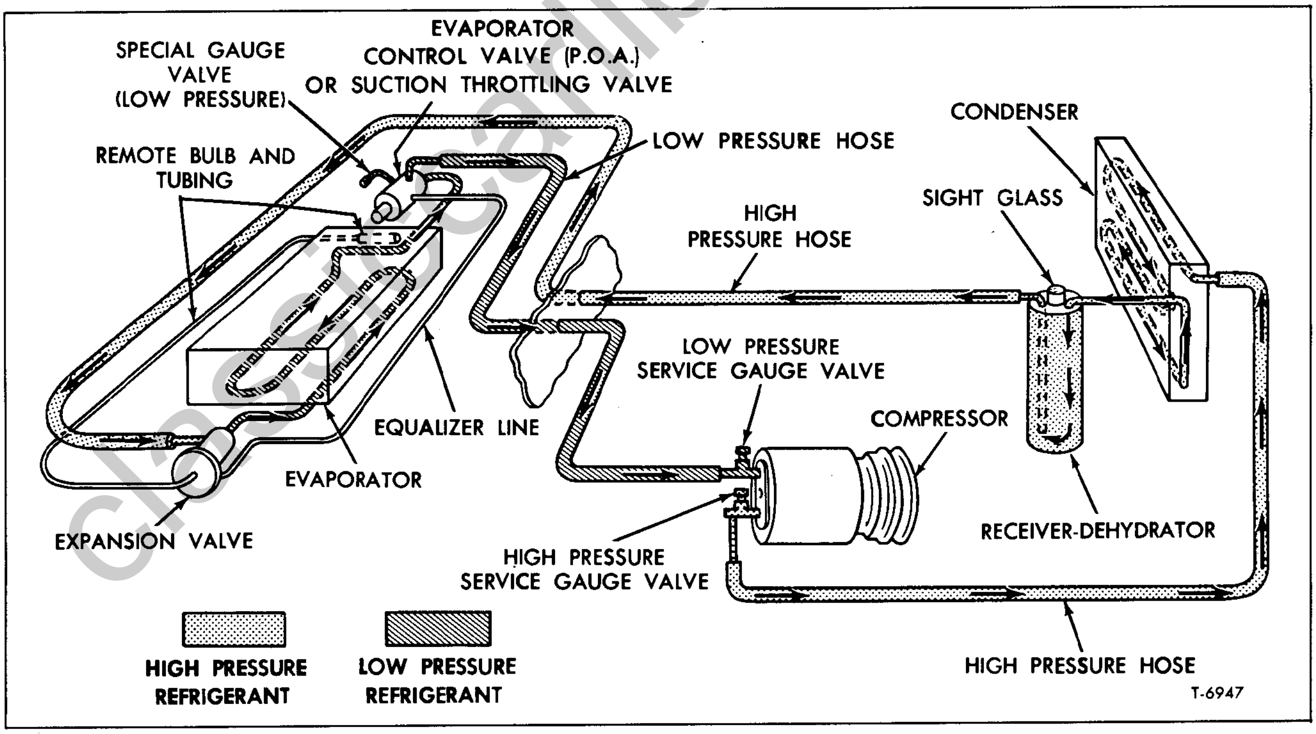

Figure 3—Schematic of Refrigerant Circulation (Typical)

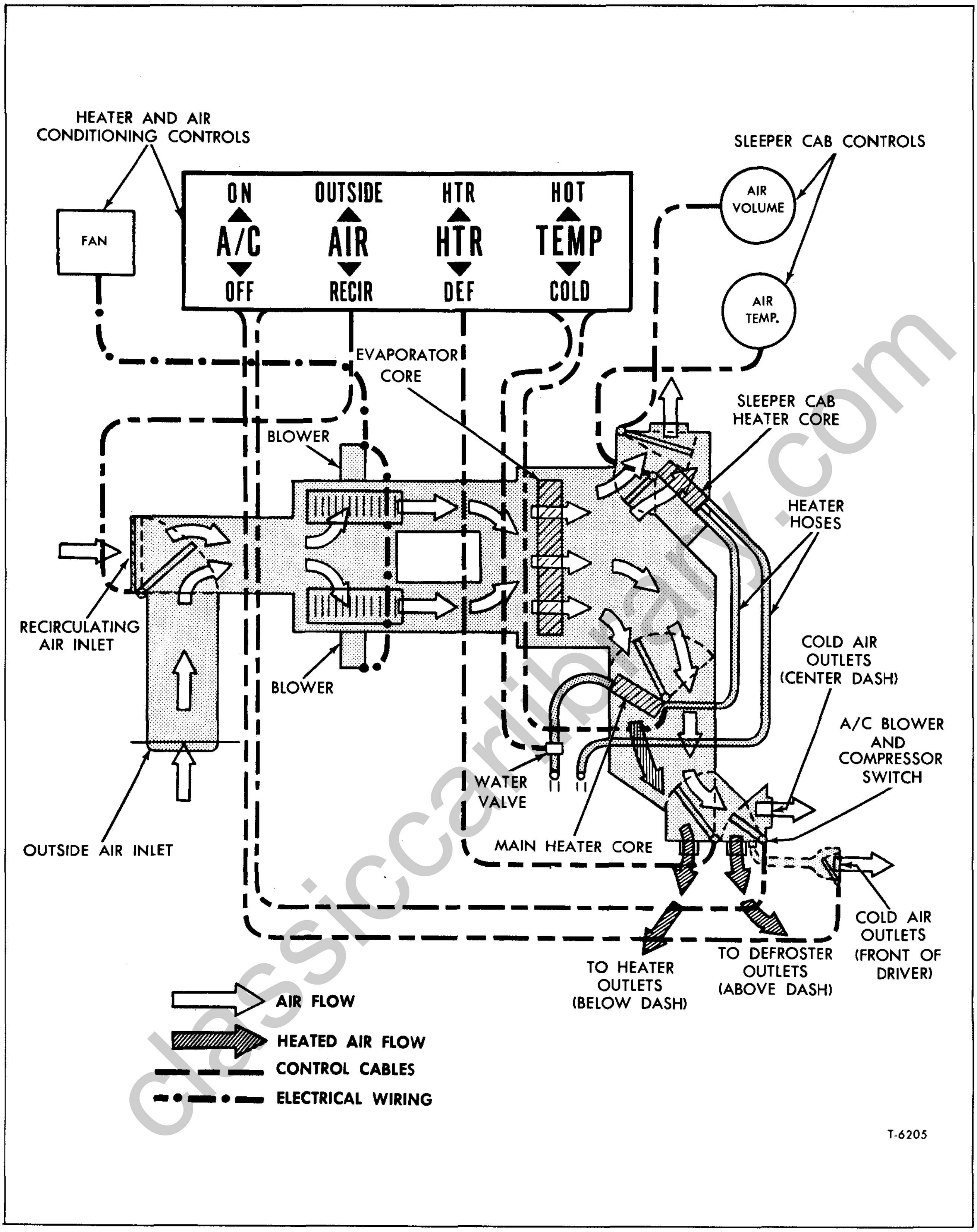

Figure 4—Air Flow and Control Schematic (Aluminum Tilt Cab Model)

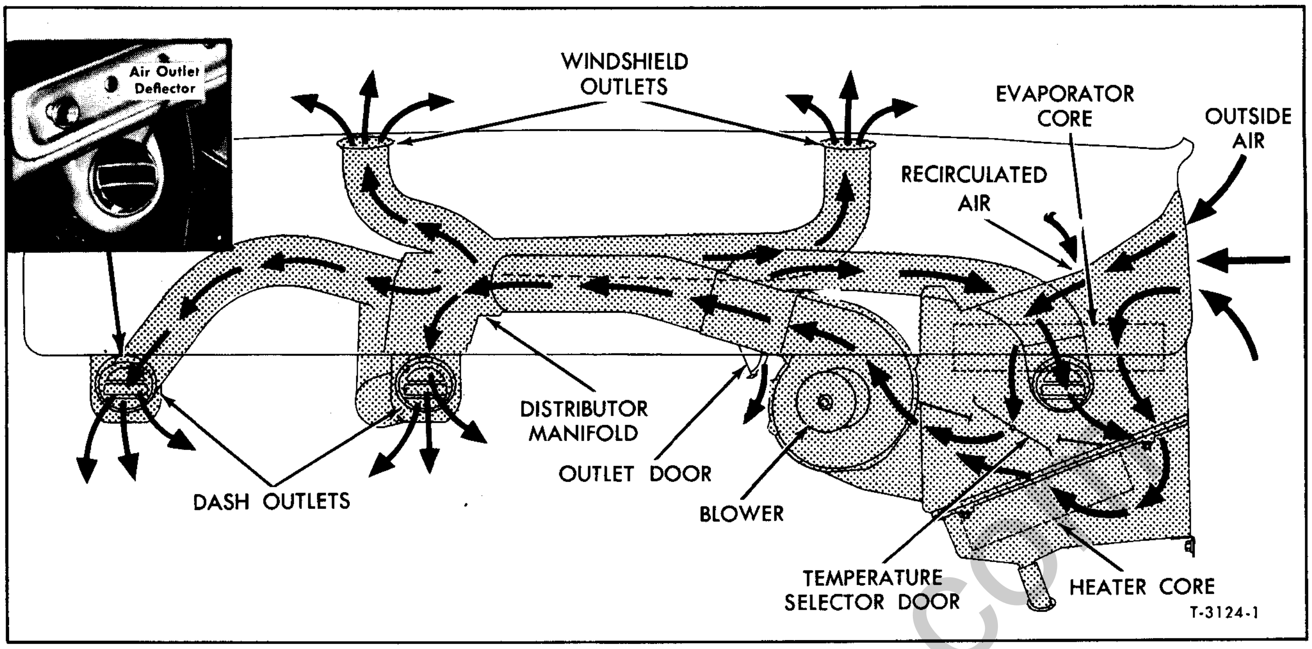

Figure 5—System Air Flow (Conventional Cab Model)

Volume of outside air entering heating system is controlled by a damper valve positioned at entrance of blower housing assembly.

NOTE: Operation of individual controls is described in "Operating Instructions" later in this section.

On Aluminum Tilt Cab Models

The air flow forced through the evaporator core and heater core results from the use of a multi-speed blower and motor assembly (fig. 4). Motor speed is controlled by a fan switch located on instrument panel.

NOTE: For additional air circulation information refer to appropriate Cab section.

On Conventional Cab Models

The air flow through evaporator coil and heater core is forced by a single blower and motor unit mounted at left side of dash unit (fig. 5). Motor is controlled by dash switches.

OPERATING INSTRUCTIONS

NOTE: Before starting truck engine, make sure "AIR COND." lever is in "OFF" position to lessen the load on battery during starting.

ALUMINUM TILT CAB

(Refer to Figure 4)

The heating and air conditioning systems are controlled by four levers and a four-position fan switch. All controls are located on the console to the right of the gauge panel.

1. The A/C lever, when moved to the "ON" position, energizes the compressor clutch-coil to allow refrigerant flow through evaporator core. Also, the blower operates at low speed which results in cooling of air directed through evaporator core. To obtain greater air flow, use "FAN" switch.

2. The "AIR" lever controls the source of air through system. Push knob up for outside air; push knob down to recirculate inside air. Intermediate positions of lever will result in a proportional mixture of outside and recirculated air flow through system.

3. The "HTR" lever controls the direction of air flow from system. Push knob up to direct air flow through heater outlets; push knob down to direct air flow through defroster outlets. Intermediate positions of lever will result in proportional amounts of air flow through both heater and defroster outlets.

4. The "TEMP" lever directs air flow either around or through the main heater core, or through both. Lever may be set at any position between "COOL" and "HOT" to control temperature of air circulated through cab. If A/C lever is "ON" and cab temperature is too cool for comfort, the

"TEMP" lever can be used to vary temperature of air conditioning output by mixing warm and cool air in system. When using the air conditioning system, do not move "HTR" knob all the way to the "HTR" position as this will direct all cool air to the floor through main heater core and defeat cooling effect of air conditioning. If air directed through heater ducts to cab floor is desired, move "HTR" knob part way between "HTR" and "DEF."

5. The "FAN" switch controls the speed of the blower motors. The four switch positions are "OFF" (lever down), "Low," "Medium," and "High" (lever up). The blower is used to move air for the heater, defroster, sleeper compartment heater, and air conditioning system.

6. Direction of air flow from A/C outlets mounted on center console can be controlled by changing position of deflectors. Direction of air flow from A/C outlet directly in front of driver can be controlled by repositioning outlet deflector.

The exhaust system should be inspected for leaks and missing or damaged parts each time the vehicle is lubricated.

OPERATING AIR CONDITIONING SYSTEM

IMPORTANT: Be sure A/C lever is in the "OFF" position to reduce electrical load on battery when starting engine.

1. With engine running, move A/C control lever to "ON" position. Blower will automatically operate at low speed.

2. Move "AIR" lever to "OUTSIDE." "HTR" lever between "HTR" and "DEF," and "TEMP" lever to "COLD."

3. Place blower control switch to high speed and open cab entrance door fresh-air ventilator for a few minutes to expel warm air from cab.

4. When cab begins to cool, close cab door fresh-air ventilator tightly and move "AIR" lever between "OUTSIDE" and "RECIR" to provide desired mixture of both recirculated and outside air. As required, "TEMP" lever can be set between "HOT" and "COLD" positions to allow mixing of hot and cool conditioned air as required for comfortable system outlet temperatures.

OPERATING HEATING SYSTEM ONLY

1. For heating only, move A/C lever to "OFF" and "AIR" lever to "OUTSIDE." Position "TEMP" lever as required for comfortable temperature of incoming cab air.

2. Should defogging of windshield be required, open door fresh air ventilator slightly, place "HTR" lever to "DEF" and operate blower at high speed.

3. For warm weather ventilation, less air conditioning, place A/C lever on "OFF," "AIR" lever on "OUTSIDE." "HTR" lever on "HTR," "TEMP" lever on "COLD," and then place blower switch on "High Speed." Air flow will be directed through heater outlets and not A/C outlets.

SLEEPER CAB HEATER

Models with a sleeper cab have an auxiliary heating system. There are two controls for operating this system. The control knobs are located to the right of the driver, rearward of the main heating and air conditioning control panel on the console. One knob controls the volume of air flow into the sleeper compartment and the other controls the temperature of the air. For greater volume and/or higher temperature, pull knobs out. For less volume and/or lower temperature, push knobs in.

WARNING: Before sleeping in cab, make sure that adequate ventilation will be provided.

CONVENTIONAL CAB MODELS

(Refer to Figures 5 and 6)

1. With the engine running:

a. Place "AIR COND." control lever to "ON."

NOTE: Blower motor will automatically operate at low speed.

b. Place "AIR" control lever to "A/C."

c. Select blower speed.

NOTE: For rapid cool-down, place blower control switch lever to "High-Speed" position. Also open windows for a minute or two to expel warm air from cab.

2. After desired temperature in cab is obtained move "AIR" lever to "NORMAL" position, which will generally provide an ideal mixture of both recirculated air and outside air for maximum comfort.

3. If desired, the "TEMP" lever can also be moved to any degree towards the "HOT" position, to provide maximum comfort by cooling, dehumidifying, then re-heating the air flowing through the system.

NOTE: For heating only, leave "AIR COND." lever in "OFF" position and move "AIR" lever to "OUTSIDE," then operate system as described on the following page.

NOTE: The air flow direction from any one of the dash outlets can be controlled by positioning of outlet inner deflector. The inner deflector can also be oscillated to completely close the outlet if desired. To close off any one of the outlets will increase the flow from remaining open outlets. The small outlet door at base of distributor duct can be opened if desired by pulling downward on door tab.

OPERATING HEATING SYSTEM ONLY

All four control knobs are in "OFF" position when placed to extreme left side of control panel.

"DEFROST" knob controls flow of air to the windshield defroster ducts. With knob all the way to the right, entire heater output is diverted to the defroster ducts for defrosting.

> **WARNING-CARBON MONOXIDE**
>
> To keep out offensive odors and exhaust gases when in congested traffic, or parked behind a vehicle with its motor running, close outside air intake ventilators. An outside air intake is used with heater. Close this intake to minimize introduction of contaminated air into cab; this is accomplished by moving "AIR" lever on heater control panel to "RECIR" position. Avoid inhaling exhaust gases when any concentration of these are present in the air; i.e., in a garage or when parked for extended periods with engine running. Exhaust gases have strong odors which normally should give warning of their presence. However, the exhaust gases from some vehicles may not be so noticeable under certain conditions and the senses of people react differently. Exhaust gases contain a percentage of carbon monoxide which is a poisonous gas that, by itself, is tasteless, colorless, and odorless.

"TEMP" knob sets the air temperature door in desired position. As knob is moved to right of panel, the air leaving the system is increased. Knob can be set at any position to maintain desired temperature. To direct additional air flow towards passenger's side of cab, a small door at base of

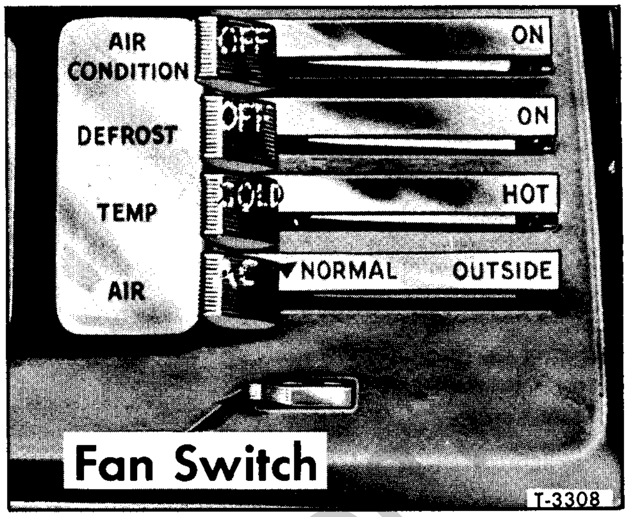

Figure 6—Air Conditioning Control Switch (Conv. Cab Model)

the blower distributor duct, under the dash, can be pulled downward.

"AIR" knob controls flow of outside air through the heater unit. Place knob in extreme right position for heating only.

HEATER FAN SPEED is controlled by moving blower switch lever from left to right positions; Off - Low Speed - Medium Speed - and High speed.

For warm weather ventilation less air conditioning, place "AIR COND." lever, "DEFROST" and "TEMP" control knobs in extreme left positions, move "AIR" knob to extreme right position, then place fan switch lever to desired speed position. Ventilation will be directed through heater outlets and not A/C outlets.

SYSTEM OPERATION

Contents of this Sub-Section are as follows:

GENERAL OPERATION

Some controls and units used with the air conditioning system are common to the heating system. These controls and units are: Control switches, heater core, air intake and distribution ducts.

The heating and cooling systems operate independently of each other, except under certain conditions of cooling system operation when there is an overlapping operation of both systems as explained previously under "Operating Instructions."

FUNDAMENTAL PRINCIPLES OF REFRIGERATION

The principle of operation of the refrigeration system is based on a few simple laws of physics which are stated informally as follows:

REFRIGERANT-12
PRESSURE-TEMPERATURE RELATIONSHIP

The table below indicates the pressure of Refrigerant-12 at various temperatures. For instance, a drum of Refrigerant at a temperature of 80°F. will have a pressure of 84.1 psi. If it is heated to 125°F. the pressure will increase to 167.5 psi. It also can be used conversely to determine the temperature at which Refrigerant-12 boils under various pressures. For example, at a pressure of 30.1 psi, Refrigerant boils at 32°F.

TEMP. (°F.)	PRESSURE (PSIG)	TEMP. (°F.)	PRESSURE (PSIG)
-21.7	0 (atmospheric pressure)	55	52.0
		60	57.7
-20	2.4	65	63.7
-10	4.5	70	70.1
- 5	6.8	75	76.9
0	9.2	80	84.1
5	11.8	85	91.7
10	14.7	90	99.6
15	17.7	95	108.1
20	21.1	100	116.9
25	24.6	105	126.2
30	28.5	110	136.0
32	30.1	115	146.5
35	32.6	120	157.1
40	37.0	125	167.5
45	41.7	130	179.0
50	46.7	140	204.5

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Figure 7—Pressure Temperature Chart

1. Temperature is a measurement of the intensity of heat.

2. Heat is a form of energy. When heat is added to a substance, it usually is noticed by an increase in temperature. For example, in order to raise the temperature of water from 35°F. to 100°F., it is necessary to add a certain amount of heat.

3. When an object cools, it does not absorb cold, but rather it loses heat to a colder object or substance nearby. When a bottle containing warm liquid is placed on a cake of ice, the ice will melt and the bottle and its contents will become cool. Heat from the bottle and its contents is lost to the ice.

4. When a liquid boils, turning to vapor, it absorbs a great amount of heat. For instance, water boiling on a stove is absorbing a great amount of heat from the burner as it is changing to the vapor commonly called steam. Boiling is a rapid form of evaporation.

When a liquid boils, it absorbs heat without changing temperature. For example, when heat is added to water at sea level, as when heating on a stove, the temperature of the water will rise until it reaches 212°F. If the water remains on the hot stove, it will boil, but the temperature will remain at 212°F. The heat being absorbed by the water is changing it to steam rather than raising the temperature.

Refrigerant-12 used in air conditioning system boils at 21.7°F., below zero. Thus, if it were exposed to the air at normal room temperature, it would absorb heat from surrounding air and boil, immediately changing to a vapor.

5. When heat is removed from water vapor, it will condense back into a liquid. For example, the steam caused by boiling water on a stove will condense into water on the underside of the cover. This is due to the fact that the cover is not as hot as the steam. The cover, therefore, takes heat from the steam, condensing it back to water.

6. The temperature at which substances will boil or condense is affected by pressure. Refer to "Pressure Temperature Chart" (fig. 7). If the pressure is increased, the liquid will not boil until a higher temperature is reached. Thus, we can prevent refrigerant from boiling if it is kept under high pressure. If this high pressure is suddenly released, refrigerant will immediately boil. This has been demonstrated on modern vehicles with pressure cooling systems.

When the pressure of a vapor is increased, the temperature at which it will condense is also raised. Steam condenses below 212°F., if heat is removed from it, but it can be made to condense at higher temperature by increasing the pressure.

7. Compressing a vapor increases its temperature. For example, when pumping air into a tire with hand pump, the pump will become warm due to the heating of the air as it is compressed.

8. When a liquid is heated until it is converted to a gas, then this gas is heated additionally without changing pressure, the gas is said to be superheated. For instance, in the evaporator, refrigerant absorbs heat and boils at a constant temperature and pressure until it has been completely vaporized, and it continues to absorb heat from the warm air passing over the evaporator without any increase in pressure. Since this heat is no longer being used to convert the refrigerant from a liquid to a gas, it will now cause the temperature of the refrigerant to rise. The refrigerant is then superheated.

REFRIGERANT

The refrigerants used are commonly known by their trade name of "Freon-12," "Ucon-12," or "Genetron-12." Regardless of brand, refrigerant-12 must be used. The chemical name of refrigerant-12 is dichlorodifluoromethane (CCL_2F_2).

REFRIGERANT CHARACTERISTICS

Refrigerant exists as a gas at atmospheric pressure and must be held under pressure to remain liquid. At ordinary temperatures, it will exist as a liquid under a pressure of about 75 pounds per-square-inch.

Refrigerant has very little odor, but in large concentrations a distinct odor may be detected. It is colorless in both its liquid and gaseous states.

Refrigerant is nonpoisonous, nonflammable, and nonexplosive. It is noncorrosive to any of the ordinary metals.

Goggles should be worn whenever there is the slightest possibility of refrigerant coming in contact with the face or eyes, because refrigerant evaporates and cools so rapidly it will cause an injury similar to frostbite.

PROCUREMENT

Refrigerant is generally shipped and stored in 25-lb. drums and 15-oz. cans.

It will be impossible to draw all the refrigerant out of the drum. The use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the drum. Be sure to follow the instructions under "Charging The System" explained later.

PRECAUTIONS IN HANDLING REFRIGERANT

1. DO NOT leave container of refrigerant uncapped.
2. DO NOT subject container to high temperature.
3. DO NOT weld or steam clean on or near system.
4. DO NOT fill drum (when used) completely.
5. DO NOT discharge vapor into area where flame is exposed.
6. DO NOT expose eyes to liquid.

All refrigerant drums are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is good practice to replace the cap after each use of the drum for the same reason. If the drum is exposed to the radiant heat from the sun, the resultant increase in pressure may cause the safety plug to release or the drum to burst.

For the same reason, the refrigerant container should never be subjected to excessive temperature when charging a system. The refrigerant drum (when used) should be heated for charging purposes by placing in 125°F. water. Never heat above 125°F., or use blowtorch, radiator, or stove to heat the drum.

Welding or steam cleaning on or near any of the refrigerant lines or components of the air conditioning system could build up dangerous and damaging pressures in the system.

If a small drum is ever filled from a large one, never fill the drum completely. Space should always be allowed above the liquid for expansion. Weighing drums before and during the transfer will determine fullness of drums.

Discharging large quantities of refrigerant into a room can usually be done safely as the vapor would produce no ill effects. However, this should not be done if the area contains a flame-producing device such as a gas heater. While refrigerant normally is nonpoisonous, heavy concentrations of it in contact with a live flame will produce a poisonous gas. The same gas will attach all bright metal surfaces.

PRECAUTIONS

DO NOT EXPOSE EYES TO REFRIGERANT

One of the most important precautions is protection of the eyes when handling refrigerant. Any liquid refrigerant which may accidentally escape is approximately 21.7°F., below zero. If any refrigerant comes in contact with the eyes, serious injury could result. Always wear goggles to protect the eyes when handling refrigerant.

If refrigerant should come in contact with the eyes:

1. **DO NOT rub the eyes. Splash the eyes with cold water to gradually get the temperature above the freezing point.**
2. **Apply a protective film of an antiseptic oil over the eye-ball to reduce the possibility of infection.**
3. **Consult a doctor or an eye specialist immediately.**

Should liquid refrigerant come in contact with the skin, the injury should be treated the same as though the skin had been frostbitten or frozen.

REFRIGERANT CIRCULATION

Refrigerant control units and piping is illustrated in figures 1 and 2. A complete cycle of the refrigerating system (fig. 3) is as follows:

1. Refrigerant in its gaseous state is drawn into the compressor where it is compressed and discharged into the condenser.
2. As the heated gas circulates through the condenser coils, it is cooled by air being forced through the condenser by an engine cooling fan. The combined effects of the decreased temperature and increasing pressure cause the gas to condense (liquify).
3. The liquid refrigerant is then forced from condenser into the liquid receiver.
4. By its own pressure, liquid refrigerant is forced from liquid receiver-dehydrator through the expansion valve and into the evaporator.
5. In the evaporator, where the pressure is

reduced, the liquid refrigerant evaporates, or changes into its gaseous state. As the liquid evaporates, heat is absorbed from the air passing through the evaporator coils, thus the air is cooled.

6. Flow of refrigerant into the evaporator is regulated by the expansion valve. The expansion valve is actually a pressure reducing valve which serves two purposes:

a. It maintains pressure on the liquid line.

b. It admits only the required amount of liquid refrigerant into the evaporator, this requirement being determined by the temperature of the gaseous refrigerant at the evaporator outlet.

7. The low pressure refrigerant gas passes from the evaporator through the suction throttling valve, then back through the suction line to compressor thus completing the cycle.

AIR CIRCULATION

Air circulation is common to both the heating and air conditioning systems. For detailed description of air circulation in vehicle, refer to "Operating Instructions" explained previously, and also to the following illustrations figures 8 through 13.

AIR OUTLETS

Refrigerated air enters the interior of the cab through outlets at the instrument panel.

Air outlets can be individually controlled to provide a comfortable air flow in any direction desired by the occupants.

OPERATION OF INDIVIDUAL UNITS

Figures 2 and 3 illustrate the location of the Air Conditioning System units. Each of the units in the air conditioning system is described following:

EXPANSION VALVE

The expansion valve (fig. 14) consists of a capillary bulb and tube which is connected to an operating diaphragm (which is sealed within the valve itself) and an equalizer line which connects the valve and the low pressure return line.

The purpose of the expansion valve is to regulate the flow of liquid refrigerant into the evaporator automatically in accordance to the requirements of the evaporator.

The valve is the dividing point in the system between high pressure liquid refrigerant supplied from the receiver-dehydrator and relatively low pressure liquid and gaseous refrigerant in the evaporator. It is so designed that the temperature of the refrigerant at the evaporator outlet must have 10.6°F., of super heat before more refrigerant is allowed to enter the evaporator. Superheat is an increase in temperature of the gaseous refrigerant above the temperature at which the refrigerant vaporizes.

A capillary tube filled with carbon dioxide and the equalizer line provide the temperature regulation of the expansion valve. This capillary tube is fastened to the low pressure refrigerant pipe coming out of the evaporator so that it communicates the temperature of the refrigerant at this point to the expansion valve. If the superheat at the outlet decreases below 10.6°F., the expansion valve will automatically reduce the amount of refrigerant entering the evaporator, thus reducing the amount of cooling. If the superheat increases, the expansion valve will automatically allow more refrigerant to enter the evaporator, thus increasing the cooling.

The equalizer line joining the suction throttling, or P.O.A., valve with the area behind the operating diaphragm acts with the capillary to measure superheat.

It is the temperature of the air passing over the evaporator core that determines the amount of refrigerant that will enter and pass through the evaporator. When the air is very warm, the heat transfer from the air to the refrigerant is great and a greater quantity of refrigerant is required to cool the air and to achieve the proper superheat on the refrigerant gas leaving the evaporator. When the air passing over the evaporator is cool, the heat transfer is small and a lesser quantity of refrigerant is required to cool the air and to achieve the proper superheat on the refrigerant gas leaving the evaporator.

Since the evaporator outlet pressure is proportionate to the amount of heat (superheat) picked up by the refrigerant gas in passing through the evaporator, it can be seen that adjusting spring tension which works against capillary pressure and equalizer line pressure controls the volume of refrigerant entering the evaporator as signaled by the temperature and pressure in the evaporator outlet pipe.

When the air conditioning system has not been operating, all pressures within the expansion valve assembly will have equalized at the ambient (surrounding air) temperature, thus the pressure above and below the operating diaphragm and at the inlet and outlet side of the valve will be equal (fig. 14). (Pressure under the diaphragm is evaporator pressure. It reaches this area by means of clearance around the operating pins in the valve body which connects the area under the diaphragm with the evaporator pressure area.) While pressures in the expansion valve are almost equal, the addition of the valve adjusting spring pressure behind the valve will hold the valve over to close the valve orifice.

When the air conditioning system first begins to operate, the compressor will immediately begin

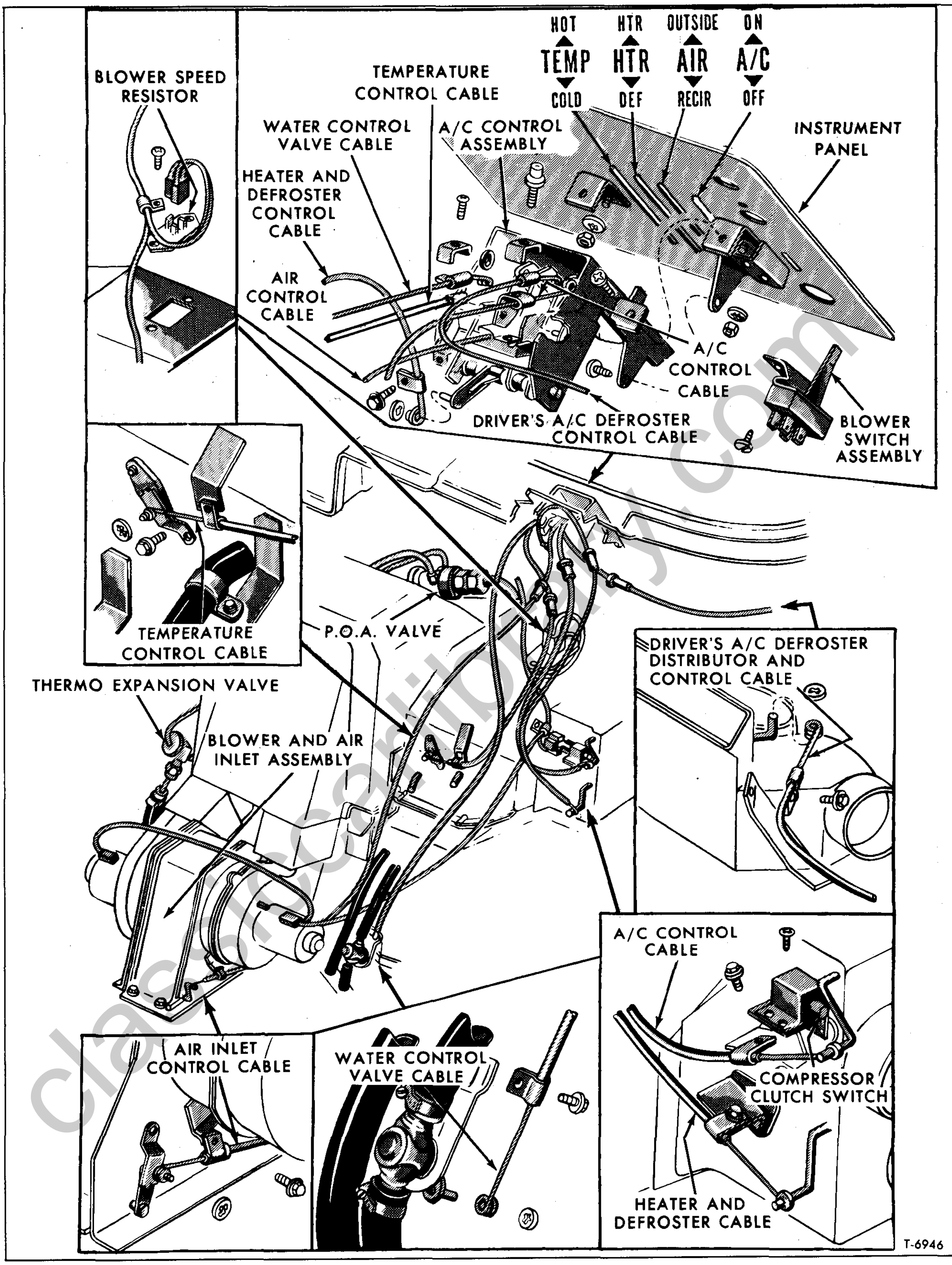

Figure 8—Air Conditioning and Heater Control (Aluminum Tilt Cab Model)

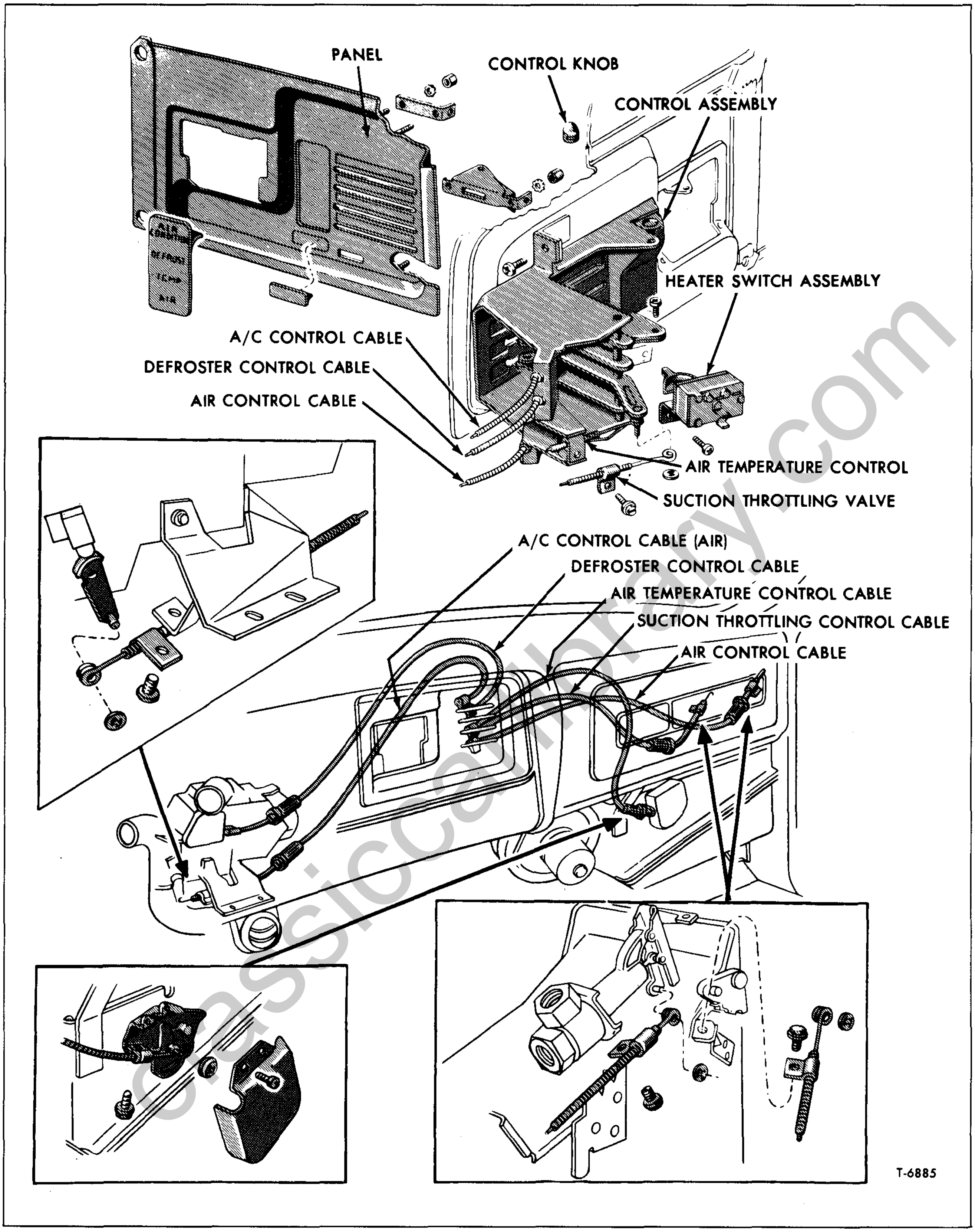

Figure 9—Air Conditioning and Heater Control (Conventional Cab Model)

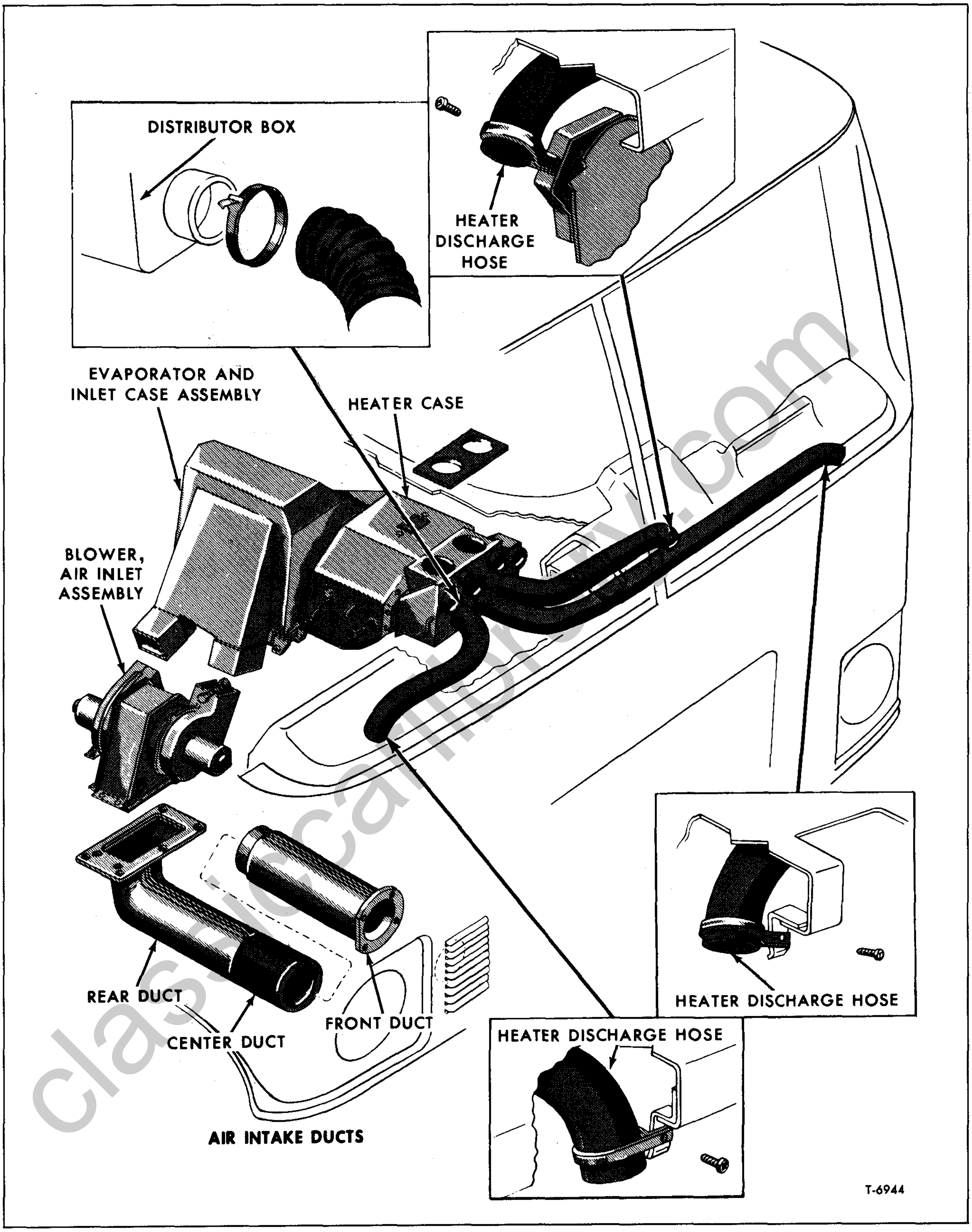

Figure 10—Heater and Air Intake (Aluminum Tilt Cab Model)

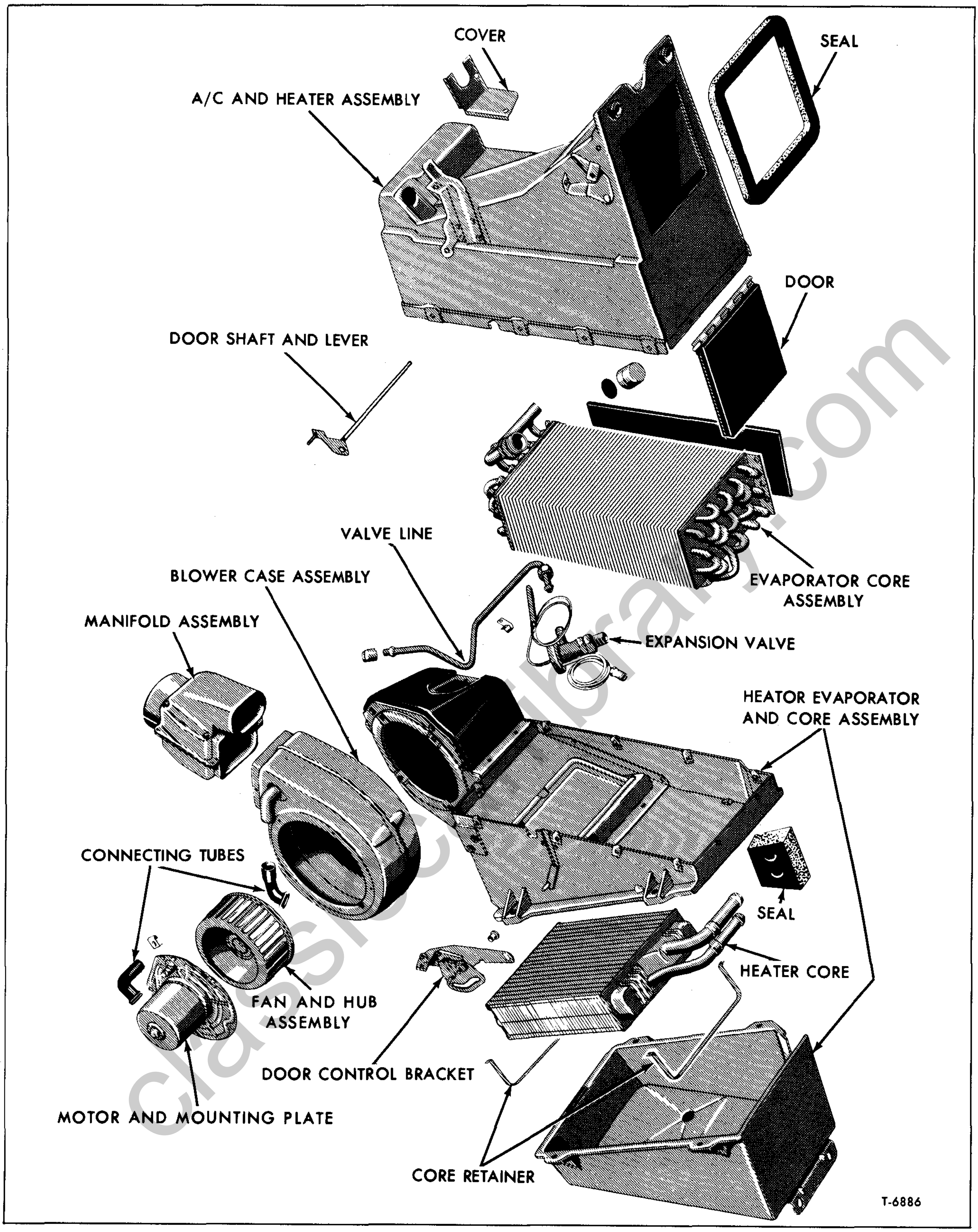

Figure 11—Heater Evaporator Blower (Conventional Cab Model)

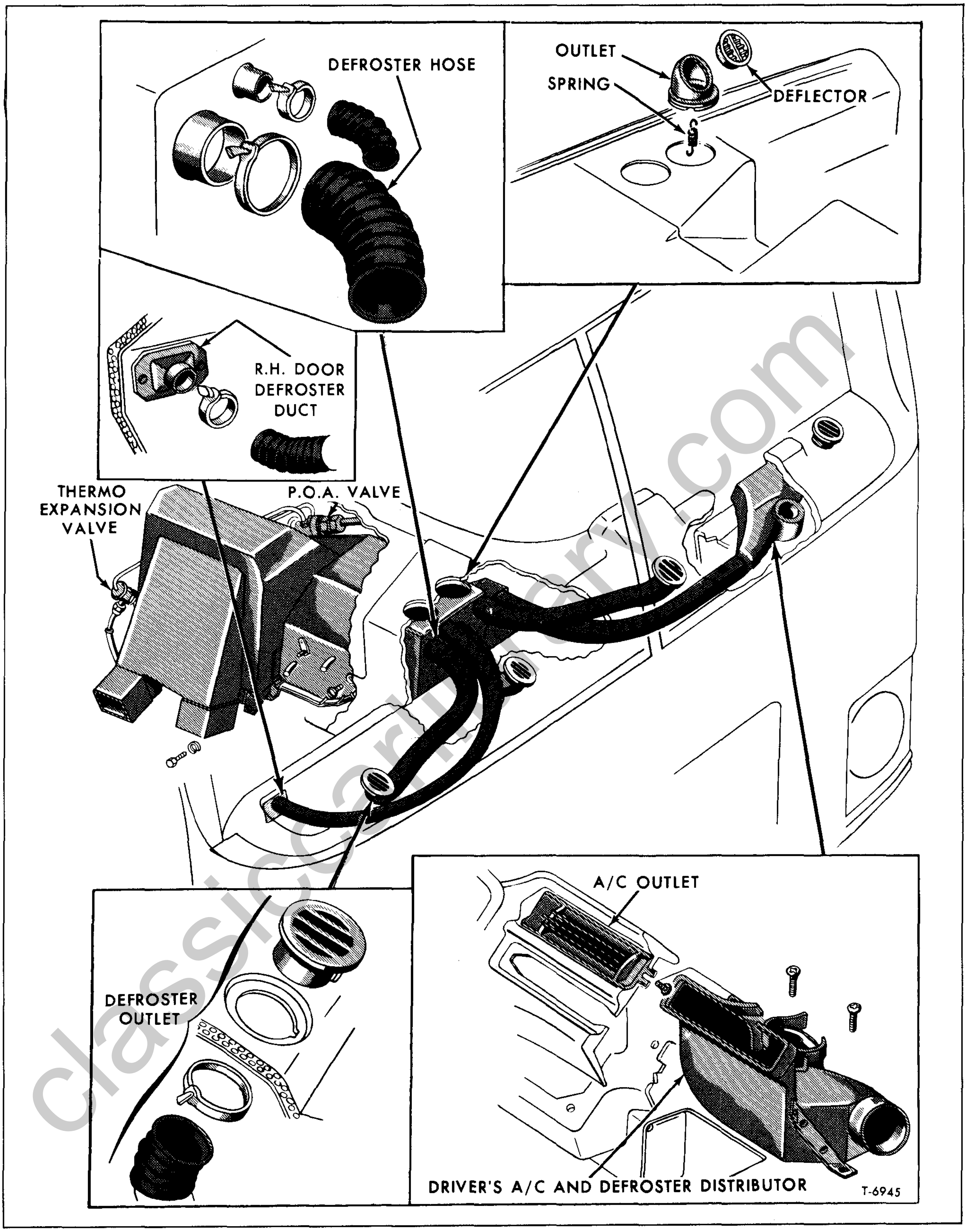

Figure 12—Air Conditioning and Defroster (Aluminum Tilt Cab Model)

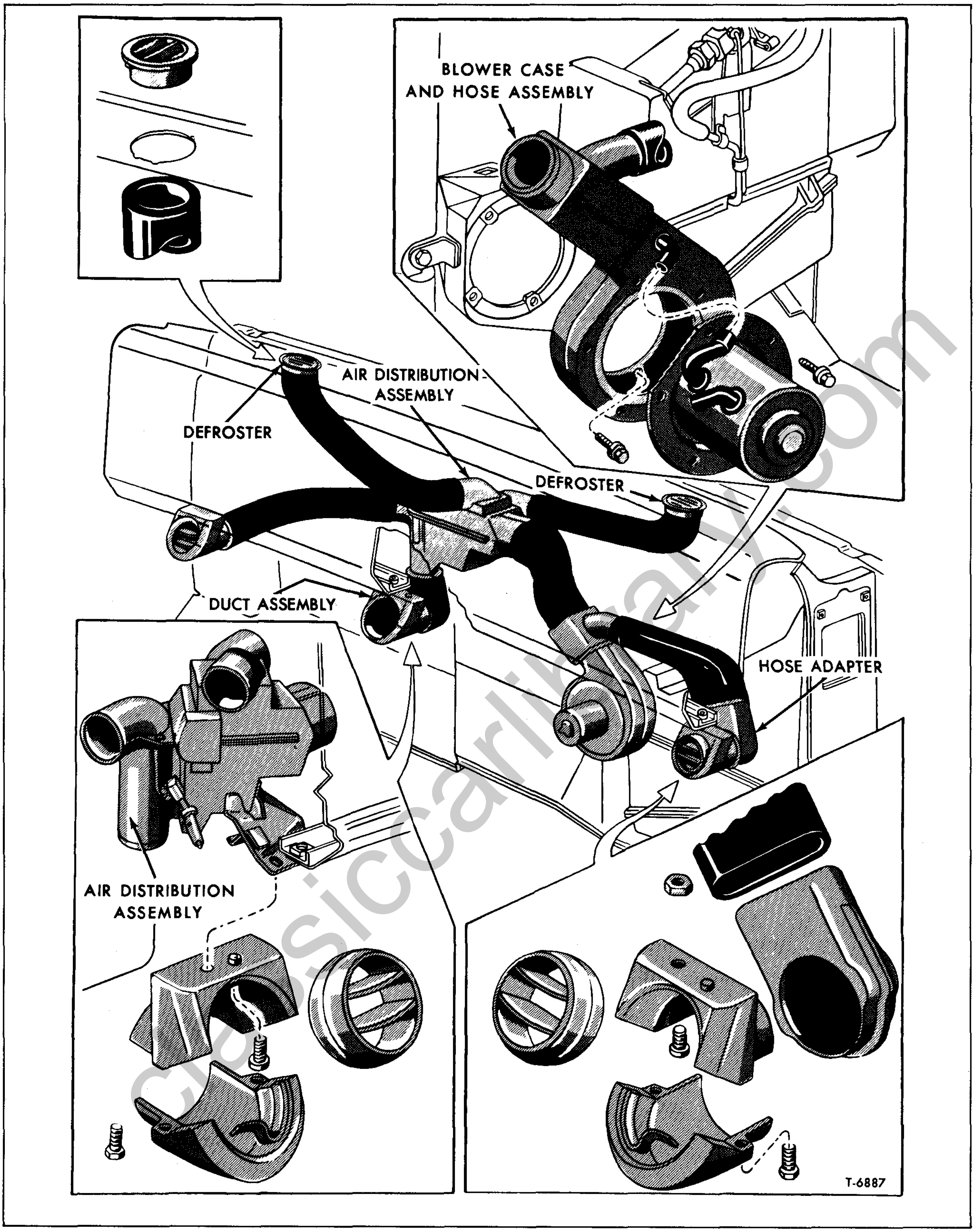

Figure 13—Air Conditioning Air Outlets and Hoses (Conventional Cab Model)

to draw refrigerant from the evaporator, lowering the pressure in the evaporator and in the area under the operating diaphragm. As the pressure in this area decreases, the pressure above the diaphragm exerted by the carbon dioxide in the capillary tube will overcome spring pressure and push the diaphragm against the operating pins, which in turn will force the needle valve off its seat.

Refrigerant will then pass through the expansion valve into the evaporator where it will boil at a temperature corresponding to the pressure in the evaporator. This will begin cooling the air passing over the evaporator, and, also it will begin to cool the evaporator outlet pipe.

As the evaporator outlet pipe cools, the pressure of the carbon dioxide in the capillary tube (contacting this outlet pipe) decreases, exerting less force on the operating diaphragm.

The valve adjusting spring is calibrated so that the pressure of the refrigerant in the evaporator, plus the spring force, will equal the force above the operating diaphragm when the temperature of the refrigerant in the evaporator outlet is 10.6^{o}F., above the temperature of the refrigerant entering the evaporator. In other words, the refrigerant should remain in the evaporator long enough to completely vaporize and then warm (superheat) 10.6^{o}F.

If the temperature differential begins to go below 10.6^{o}F. (outlet pipe becomes too cold), carbon dioxide pressure in the capillary tube and area above the diaphragm decreases, allowing the valve adjusting spring to move the needle valve toward its seat, closing off the flow of refrigerant past the needle valve.

If the temperature differential begins to go above 10.6^{o}F. (outlet pipe too warm), the pressure in the capillary tube and area above the operating diaphragm will increase, pushing this diaphragm against operating pins to open needle valve further, admitting more refrigerant to the evaporator.

EVAPORATOR

The evaporator is actually the device which cools and dehumidifies the air before it enters the cab. High pressure liquid refrigerant flows through the valve orifice in the expansion valve into the low pressure area of the evaporator. This regulated flow of refrigerant boils immediately. Heat from the core surface is lost to the boiling and vaporizing refrigerant, which is cooler than the core, thereby cooling the core. The heat in the air passing over the evaporator loses its heat to the cooler surface of the core, thereby cooling the air. As the process of heat loss from the air to the evaporator core surface is taking place, any moisture (humidity) in the air condenses on the outside surface of the evaporator core and is drained off as water.

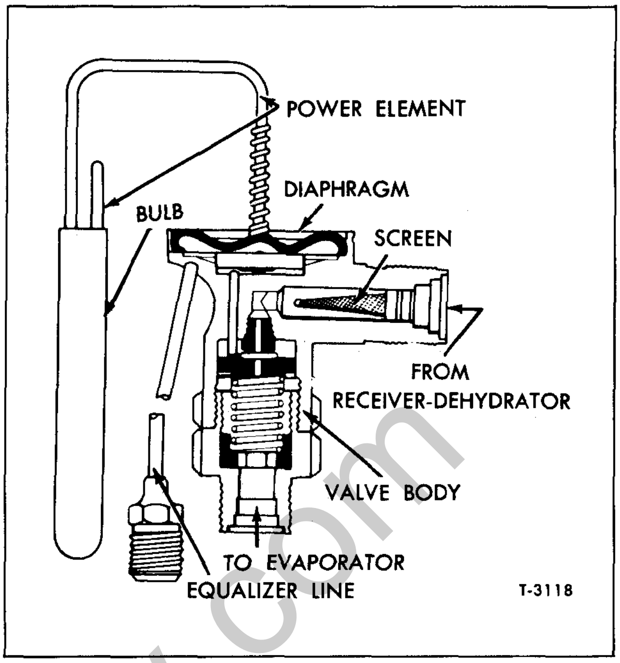

Figure 14—Expansion Valve

Since Refrigerant-12 will boil at 21.7^{o}F., below zero at atmospheric pressure and water freezes at 32^{o}F., it becomes obvious that the temperature in the evaporator must be controlled so that the water collecting on the core surface will not freeze in the fins of the core and block off the air passages. In order to control the temperature, it is necessary to control pressure inside the evaporator and this is done by the suction throttling, or P.O.A. valve.

To obtain maximum cooling the refrigerant must remain in the core long enough to completely vaporize and then superheat a minimum of 10.6^{o}F. If too much or too little refrigerant is present in the core, then maximum cooling efficiency is lost. An expansion valve in conjunction with the suction throttling, or P.O.A. valve is used to provide this necessary refrigerant and pressure control.

EVAPORATOR CONTROL VALVE (P.O.A.) (ALUMINUM TILT MODELS)

The main function of the evaporator control valve (P.O.A.) (fig. 15) is to maintain the evaporator pressure at a pressure sufficiently high to avoid freezing of moisture on the evaporator core and at the same time provide maximum cooling efficiency.

Operation of the evaporator control valve (P.O.A.) is similar in principle to that described for suction throttling valve. However, if the evaporator control valve malfunctions, it must be replaced since it is neither repairable or adjustable.

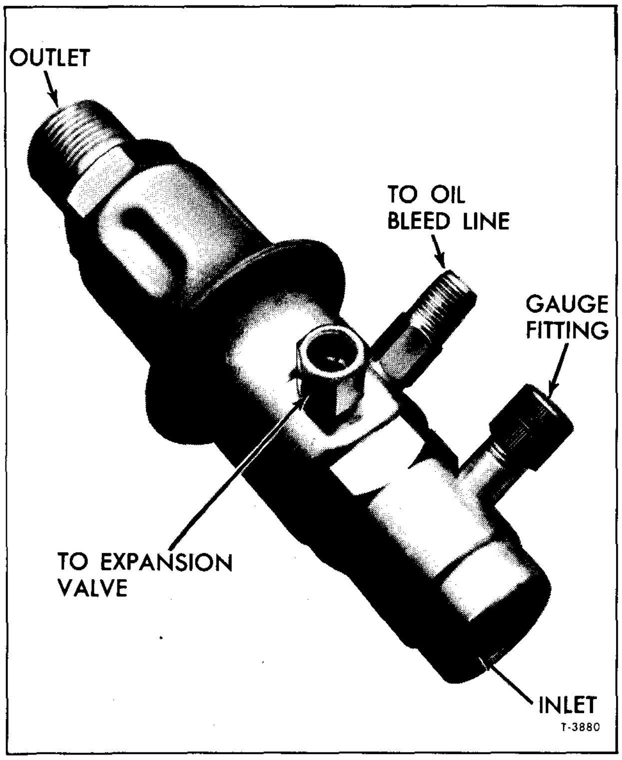

Figure 15—Evaporator Pressure Control Valve (P.O.A.)

SUCTION THROTTLING VALVE
(CONVENTIONAL CAB MODELS)

The main function of the Suction Throttling Valve (fig. 16) is to maintain the evaporator pressure at a pressure sufficiently high to avoid freezing of moisture on the evaporator core and at the same time provide maximum cooling efficiency.

The opposing forces, spring pressure and atmospheric pressure on the one side of the valve diaphragm and evaporator pressure on the opposite side of the diaphragm constitute a balanced valve and control its operation.

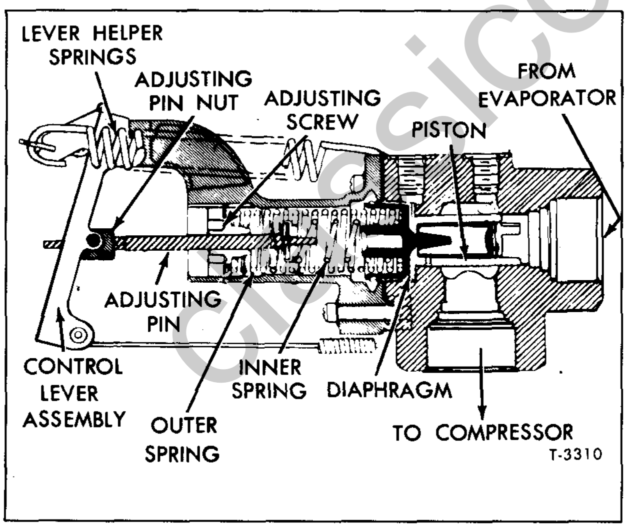

Figure 16—Suction Throttling Valve

When the evaporator pressure rises above the manual spring setting, this increase in evaporator pressure is exerted against the valve piston and through the bleed holes in the piston to the underside of the diaphragm. The pressures under the diaphragm overcomes the spring pressure causing the valve piston to move in an opening direction. As the piston opens, it reaches a balanced position and the evaporator pressure returns to its original setting (23-24 psig).

When the evaporator pressure drops below the predetermined setting, the spring pressure overcomes the opposing evaporator pressure and forces the piston in a closing direction until the predetermined pressure setting is maintained (23-24 psig). The minimum operating pressure of the suction throttling valve is pre-set by an adjustment screw. Maximum operating pressure may be obtained by means of a cable operated from the instrument panel to the lever arm on the valve. When reduced load conditions require elevated control pressures, the lever arm actuates the inner spring assembly causing the piston to throttle in a closing direction. This results in a higher evaporation pressure and the desired increase in discharge air temperature.

COMPRESSOR

The compressor is of basic double-action piston design. Three horizontal double acting pistons make up a six-cylinder compressor, and are mounted axially around the compressor shaft to operate in a front and rear cylinder assembly. These pistons operate in a 1½" bore, have a 1-3/16" stroke and are actuated by a swash plate pressed on the compressor crankshaft (see fig. 17).

Reed-type suction and discharge valves are mounted in valve plates between the cylinder assembly and the head at each end of the compressor. The heads are connected with each other by gas-tight passage ways which direct refrigerant gas to a common output.

The compressor mainshaft is driven by the pulley when the clutch coil is energized. It extends through the compressor front head, to the compressor rear head and drives the oil pump in the rear head pump cavities.

The compressor is fitted with a high pressure relief valve. If the discharge pressure ever exceeds approximately 440 psi, the relief valve opens automatically to relieve the pressure and closes again when the pressure recedes.

The pulley assembly contains an electrically controlled magnetic clutch, permitting the com-

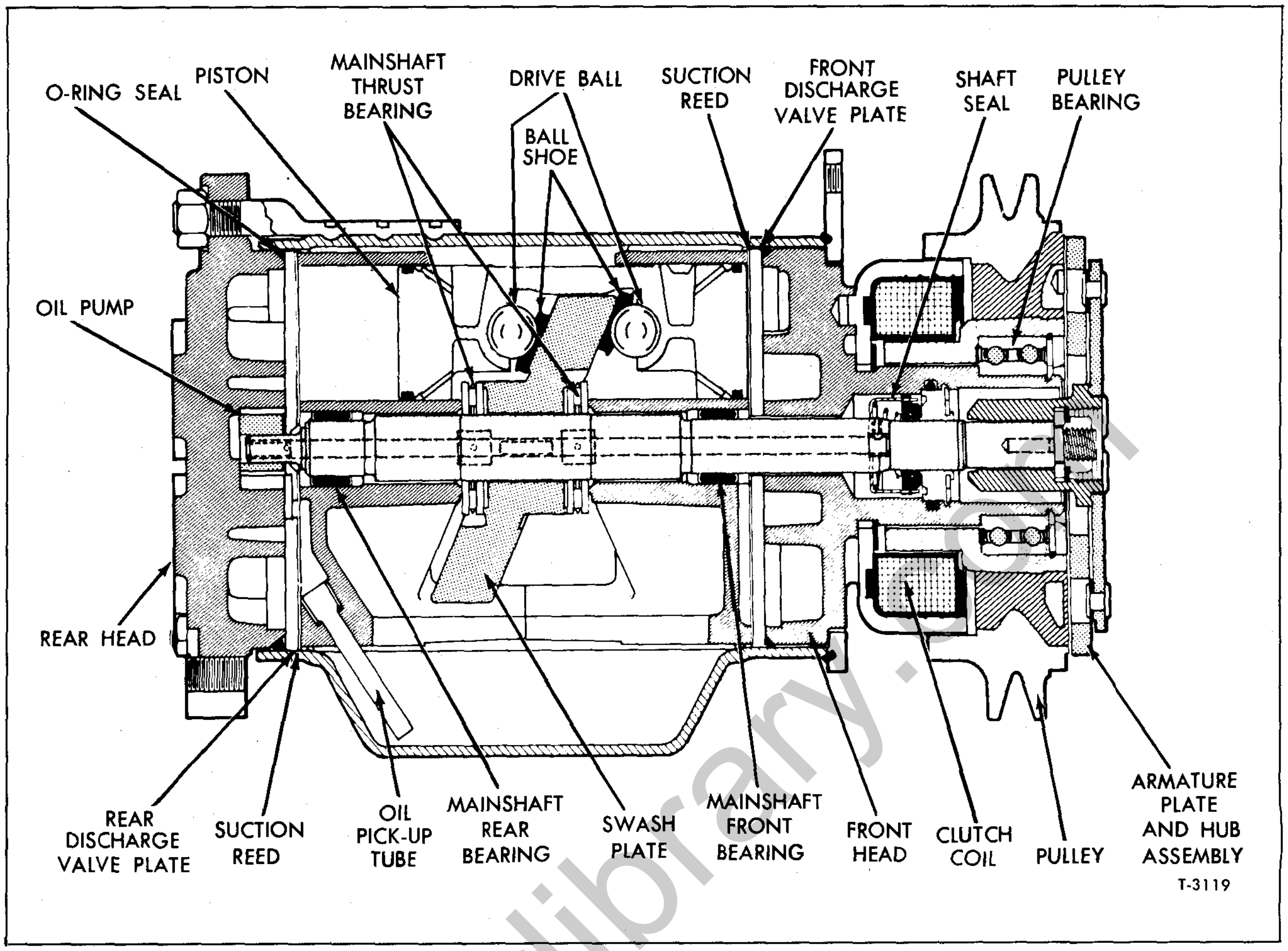

Figure 17—Refrigerant Compressor

pressor to operate only when air conditioning is desired.

The clutch actuating coil is molded into the coil housing with a potted epoxy resin; therefore, the coil and housing are replaceable only as a complete assembly. The coil has 3.85 ohms resistance at 80°F. (surrounding temperature) and should not demand more than 3.2 amperes of 12 V.D.C.

Compressor Operation

When the "AIR COND." lever is placed in "ON," the electrical circuit to the compressor clutch closes.

Current flowing through the coil creates a magnetic force which flows through the pulley to draw the armature plate (forward of the pulley assembly) rearward toward the pulley. As the armature plate moves toward the pulley, it contacts the pulley shaft face (which rotates freely about the compressor shaft).

When the "AIR COND." knob is placed in "OFF," the electrical circuit to the compressor clutch is opened and the magnetic pull on the clutch no longer exists. The armature plate to driven ring actuating springs will then pull the armature plate away from the pulley and the plate loses contact with the pulley.

A gauge fitting containing a Schrader valve is located in both the discharge and suction passage to permit pressure gauge readings.

CONDENSER

The condenser is similar to the ordinary radiator but is designed to withstand much higher pressures. It is made up of tubes which carry the refrigerant and cooling fins which provide rapid transfer of heat.

The condenser is located in front of the engine cooling system radiator so that it receives a high volume of air from the movement of the vehicle and from the engine fan. Air passing over the condenser cools the hot high pressure refrigerant gas, causing it to condense into high pressure liquid refrigerant.

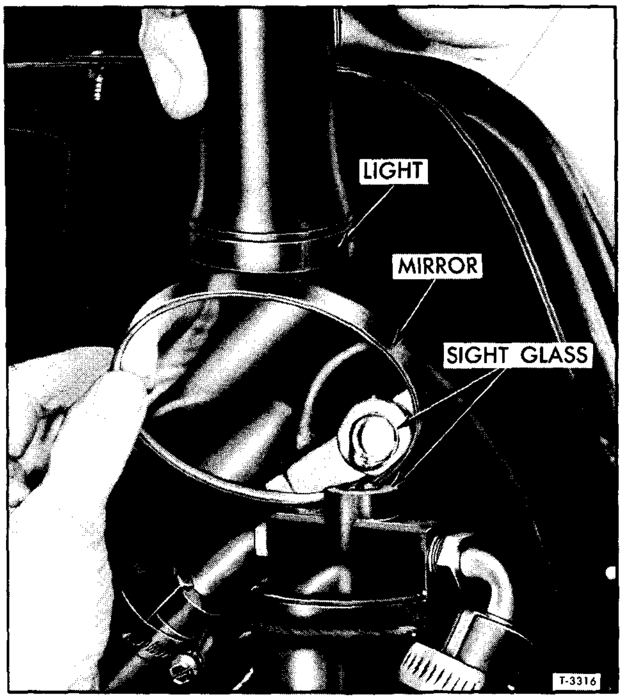

Figure 18—Receiver-Dehydrator

RECEIVER-DEHYDRATOR ASSEMBLY

The receiver-dehydrator assembly is mounted vertically along the right side of the radiator support.

The purpose of the receiver part of this system is to ensure a solid column of liquid refrigerant to the expansion valve at all times, provided the system is properly charged.

The liquid indicator (many times referred to as a sight glass) is in the refrigeration system as an aid to diagnosis (see fig. 18). The appearance of bubbles or foam beneath the sight glass (liquid indicator) above 70°F., ambient indicates air or a partial discharge of refrigerant in the system. A solid liquid column as seen in the sight glass is difficult to tell from one that has no refrigerant in the system at all.

Two ways to establish whether the system is properly charged or empty are to feel the suction pipe in the suction throttling or P.O.A. valve or to disconnect the compressor clutch while observing the sight glass. If the system has the proper refrigerant charge, the suction line at the suction throttling or P.O.A. valve will be cool. Also, the refrigerant column in the sight glass will be seen to collapse soon after the clutch has been disconnected. Foam may be noted in the sight glass below 70°F., even when the system is free of air and properly charged. Details of these conditions are in the "Insufficient Cooling Diagnosis Chart" on page 166.

Liquid refrigerant from the condenser enters the receiver to flow into the upper portion of the receiver which contains desiccant confined in a white felt bag that is not attached to anything but merely rests on the baffle in the lower portion of the receiver. As the refrigerant flows through an opening in the lower portion of the receiver, it is also filtered through a 100 mesh screen attached to a baffle at the bottom of the receiver.

The desiccant in this assembly is to absorb any moisture that might be present in the system after assembly. The screens trap any foreign material which may enter the system during assembly. These features of the assembly prevent obstruction to the valves or damage to the compressor.

NOTE: Markings on top of the receiver show the proper inlet and outlet fitting connections.

When the air conditioning system lines are to be opened for service, be sure to wear eye protection when releasing pressurized refrigerant. Should liquid refrigerant come in contact with the skin, the injured area should be treated the same as frostbitten skin.

ON-VEHICLE SERVICE

Contents of this Sub-Section are listed in Index below:

PERIODIC SERVICE

(60 Days or 6000 Miles whichever occurs first)

1. Check front of condenser for an accumulation of dirt, such as leaves, bugs, dirt, etc. Also check to see that the space between the condenser and radiator is also free of this material.

2. Inspect compressor drive belt. Check and adjust used V-belt tension 80 to 90 pounds on belt tension gauge (J-23573) and 120 to 130 pounds on new belts.

Check and adjust used Poly-V belt tension 64 to 74 pounds on belt tension gauge (J-23586) and 84 to 94 pounds on new belts.

Gauge measurement should be taken at greatest span between pulleys. For further details refer to ENGINE COOLING (SEC. 6K) of this manual.

3. Operate system and check for correct operation in all control positions.

4. Check for refrigerant leaks and observe refrigerant passing through the sight glass with system operating to see if there is any evidence of bubbles (above 70°F. ambient).

PRECAUTIONARY SERVICE MEASURES

Before any service is attempted which requires opening of refrigeration pipes or units, the person doing the work should be thoroughly familiar with "General Information" on refrigeration service.

The major reasons behind these measures are for safety and to prevent dirt and moisture from getting into the system. Dirt contaminant is apt to cause leaky valves or wear in the compressor, and moisture will freeze into ice at the expansion valve and freeze the valve stem.

PRE-ASSEMBLY

1. All sub-assemblies are shipped, sealed, and dehydrated. They are to remain sealed until just prior to making connections.

2. All sub-assemblies should be at room temperature before uncapping. (This prevents condensation of moisture from the air that enters into the system.)

3. If, for any reason the caps are removed, but the connections are not made, then the tubes and other parts should not remain unsealed for more than 15 minutes. Reseal connections if period is to be longer. This applies particularly to partially built-up systems that will be left overnight.

4. Compressors are shipped with 10 - 11 oz. of Frigidaire-525 Viscosity Oil and charged with a mixture of Refrigerant-12 and dry nitrogen to provide an internal pressure at slightly above atmospheric pressure.

ASSEMBLY

1. All precautions should be taken to prevent damage to fittings or connections. Even minute damage to a connection could cause it to leak.

2. Any fittings getting grease or dirt on them should be wiped clean with a cloth dampened with alcohol. Do not use chlorinated solvents such as trichlorethylene for a cleaning agent, as they are contaminants. If dirt, grease, or moisture gets inside the hoses and cannot be removed, the hose should be replaced.

3. Sealing caps should be removed from sub-assemblies just prior to making connections for final assembly.

4. Use a small amount of clean refrigeration oil (525 or 1000 viscosity) on all tube and hose joints, and dip the O-ring gasket (when used) in this oil before assembling the joint, as this oil will help in making a leak-proof joint.

5. Do not connect the receiver-dehydrator assembly until all other sealed sub-assemblies have been connected. This is necessary to ensure optimum dehydration and maximum moisture protection of the refrigeration system.

LIQUID INDICATOR (SIGHT GLASS)

Under normal conditions, the receiver-dehydrator will show clear with about 3 pounds of refrigerant in the system on Conventional Cab Models, or 4 pounds on Aluminum Tilt Cab Models. However, the air conditioner will not produce its best performance until 3¼ or 4½ pounds of refrigerant are in the system. Do not overcharge with refrigerant, as this will reduce system efficiency and will result in high head pressures which could cause the compressor safety valve to release.

REFRIGERANT LINES

The charged air conditioning system is sealed from the atmosphere and remains under pressure at all times. Regardless of whether or not the system is charged, it must remain sealed to prevent entrance of contaminants such as air or moisture. Therefore, if it is necessary to open the refrigerant system for parts replacement, it is imperative that the repairs be completed and system sealed as soon as possible to reduce the amount of contaminants that will enter system. Thoroughly evacuate before charging system as described in "Evacuating The System" later in this section.

When securing metal refrigerant lines by means of unions or similar connectors, a back-up wrench should be used to prevent possible twisting or excess stress on tubing. Proper torques, as shown on "Torque Specifications" chart at end of this section, are necessary to assure leak-free and secure connections.

PERFORMANCE TESTING

In order to determine if an air conditioning system is operating properly and efficiently, it must be performance tested. The first step to diagnosing a system that has been malfunctioning should be a complete performance test (see fig. 19).

Correct pressures indicate that the required charge of refrigerant is in the system and that it is functioning properly.

Testing to determine if the discharge air temperature, suction pressure, and discharge pressure meet the specifications at a particular ambient condition is called a "Performance Test."

SUCTION THROTTLING VALVE (CONVENTIONAL CAB) (Fig. 16)

The suction throttling valve is pre-set at the factory to maintain the minimum and maximum evaporator core pressure and generally should never require resetting. If a malfunction in the refrigerant system due to above or below normal evaporator core pressures is suspected, check the following:

1. Restrictions in evaporator core, hoses, tubes, etc.
2. Refrigerant leaks.
3. Compressor clutch slippage.
4. Improper drive belt tension.
5. Capillary tube broken or not tight to evaporator tube.
6. Expansion valve inoperative.
7. Suction throttling valve stuck.

The purpose of performing an operational test is to prove that the air conditioning electrical system, air system, and refrigeration system are operating properly and efficiently. Results of the test are as follows:

1. Operation of the air conditioner blower at all speeds and engagement of the compressor clutch would indicate that the electrical circuits are functioning properly.

2. A clear sight glass would indicate a properly charged refrigeration system.

3. Proper evaporator pressure, as controlled by the Suction Throttling Valve would provide proper "freeze protection" for the evaporator.

4. Proper nozzle temperatures would indicate a system free from warm air leaks.

Check and correct all air and refrigerant leaks in the air conditioning system as well as operation of cable-operated air doors.

Check for proper compressor oil level during the repair of refrigerant leaks, before conducting an operational test. (Continued on following page.)

REFRIGERANT QUICK CHECK PROCEDURE

A quick reference chart below has been provided for use in determining whether or not the air conditioning system has a proper charge of refrigerant. These simple checks can be made in matter of minutes, thus facilitating system diagnosis by pinpointing the problem to the amount of charge in the system or by eliminating this possibility from the overall checkout. Refer to "Refrigerant Quick Check Procedures" chart for exact step-by-step procedure.

REFRIGERANT QUICK CHECK PROCEDURES

(Check procedures should be made at 70° F.)

Start engine and place on fast idle. Set controls for maximum cold with blower on high.

Bubbles present in sight glass.	No bubbles. Sight glass clear.
System low on charge. Check with leak detector. Correct leak, if any, and fill system to proper charge.	System is either charged or empty. Feel high and low pressure pipes at compressor. High pressure pipe should be warm; low pressure pipe should be cold.
No appreciable temperature differential noted at compressor.	Temperature differential noted at the compressor.
System empty or nearly empty. Turn off engine and connect charging station. Induce 1/2 lb. of refrigerant in system (if system will not accept charge, start engine and draw 1/2 lb. in through low pressure side). Check system with leak detector.	Even though a differential is noted, there exists a possibility of overcharge. An overfilled system will result in poor cooling during low speed operation (as a result of excessive head pressure). An overfill is easily checked by disconnecting the compressor clutch connector while observing the sight glass.
If refrigerant in sight glass remains clear for more than 45 seconds (before foaming and then settling away from sight glass) an overcharge is indicated. Verify with a performance check.	If refrigerant foams and then settles away from sight glass in less than 45 seconds, it can be assumed that there is a proper charge of refrigerant in system. Continue checking out system using performance checks outlined in this manual.

TEST READINGS										
Ambient Air in Degrees F. (In Auxiliary Fan Air Blast 2" Ahead of Condenser).	70		80		90		100		110	
Air Quality	Arid	Humid	Arid	Humid	Arid	Humid	Arid	Humid	Arid	Humid
Average Compressor Head Pressure—PSI	125/155	150/180	160/190	180/210	197/227	213/243	225/255	250/280	270/300	290/320
Average Suction Throttling Valve Pressure—PSI	20/23	21/24	20/23	22/25	21/24	25/28	24/27	29/32	28/31	36/39
Center Outlet Temperature Degree F.	41/44	48/52	44/48	53/57	48/52	58/62	52/57	62/68	58/65	68/75

Shown in the above table are the average readings expected in arid or dry air, and in humid or moist air with maximum allowable tolerance shown.

Humid air is considered 20—90% R.H. Nozzle

Arid air is considered 5—20% R.H. Nozzle

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Figure 19—Operational Test Data Chart

P.O.A. VALVE (ALUMINUM TILT CAB)
(Refer to Fig. 15)

The only check for proper P.O.A. valve operation is to check the suction pressure at the valve as during a performance test. The P.O.A. valve is an absolute valve and will provide different gauge readings based on the altitude where the readings are being taken. Correct gauge reading at sea level is 29.5 psig. Gauge readings will be one-half psi higher for each additional 1,000 feet of elevation.

The following table lists gauge readings at different altitudes. If a valve gives improper gauge readings, it must be replaced since it is neither repairable nor adjustable:

29.5 psig. --	Sea level	32.5 psig. --	6,000 ft.
30.0 psig. --	1,000 ft.	33.0 psig. --	7,000 ft.
30.5 psig. --	2,000 ft.	33.5 psig. --	8,000 ft.
31.0 psig. --	3,000 ft.	34.0 psig. --	9,000 ft.
31.5 psig. --	4,000 ft.	34.5 psig. --	10,000 ft.
32.0 psig. --	5,000 ft.		

NOTE: Refer to "Insufficient Cooling Diagnosis Chart" and "Specifications" at end of this section for other pertinent air conditioning information related to performance testing.

PRELIMINARY CHECKS

1. Inspect compressor drive belt. Check and adjust USED V-belt tension 80 to 90 pounds on belt tension gauge (J-23573) and 120 to 130 on NEW belts. Check and adjust USED Poly-V belt tension 64 to 74 pounds on belt tension gauge (J-23586) and 84 to 94 pounds on NEW belt.
2. Check all refrigeration lines for leaks, kinks, or other restrictions.
3. Check outer surfaces of radiator and condenser cores to be sure they are not plugged with dirt, leaves or other foreign material. Be sure to check between the condenser and radiator as well as the outer surfaces.
4. Connect engine tachometer.
5. Start engine and operate at 2000 rpm with "AIR" lever on "OUTSIDE" and "TEMP" lever set for maximum cooling, and blower on "HIGH." After at least five minutes of engine operation, observe for bubbling at the sight glass (above 70°F. ambient). If the system is low on refrigerant, add refrigerant until liquid indicator just shows clear and add an additional ½-lb. of refrigerant.
6. Under the same conditions as in Step 5 previously, move "AIR COND" lever to "OFF." This should disengage the compressor clutch. If

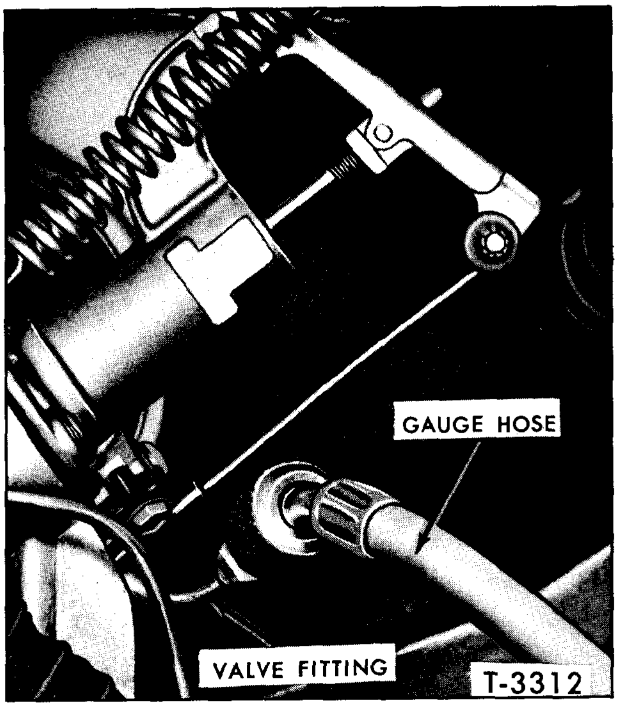


Figure 20—Gauge Hose Connections at Suction Throttling Valve

clutch does not disengage, check the clutch control switch adjustment.

7. Move "AIR COND" lever to "ON" again and observe clutch engagement action which should be without slip. If clutch slips, check clutch for proper adjustment, short in clutch coil, or leaking compressor shaft seal.

8. Change blower speed to medium, and to low, and observe for decreases in air flow.

FUNCTIONAL TEST (Fig. 19)

NOTE: This test should not be performed in direct rays of sun.

1. Connect the gauge set high pressure hose to outer gauge fitting at rear of compressor and connect 30-inch vacuum, 60-psi compound test gauge hose to refrigerant fitting at suction throttling valve (fig. 20), or low pressure line from P.O.A. valve (fig. 21).

2. Locate auxiliary fan (at least 20" in diameter) in front of condenser. Leave hood open.

3. Open both cab doors.

4. Place a calibrated thermometer in front of condenser in auxiliary fan air stream.

5. Place a second calibrated thermometer in auxiliary fan air stream to measure wet bulb temperature.

6. Connect engine tachometer.

7. Open all air outlets below dash.

8. Locate a calibrated thermometer in center outlet. Sensing bulb must not touch metal.

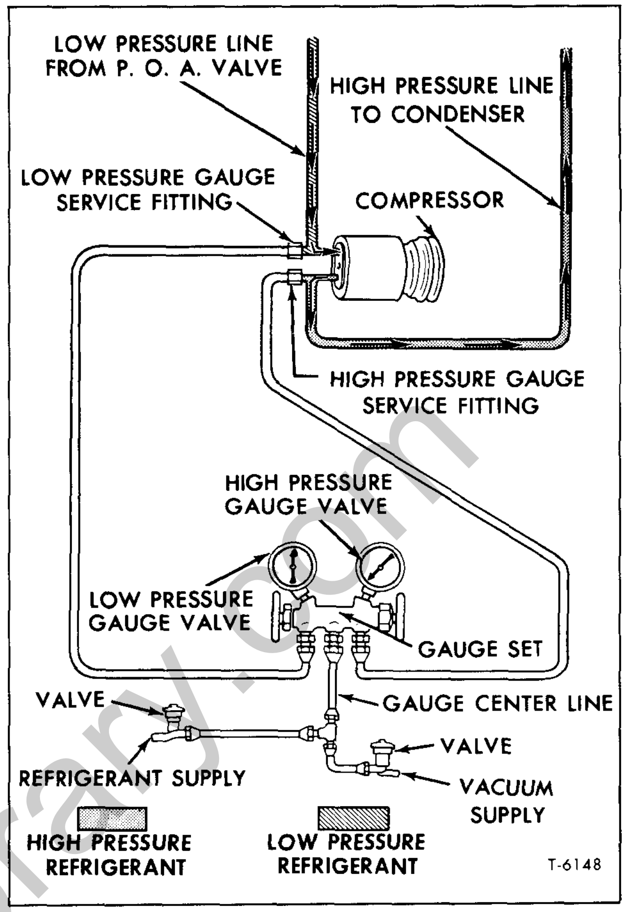


Figure 21—Schematic of Air Conditioning Gauge

9. Place transmission lever in "NEUTRAL," with parking brake on.

10. Start engine and set "AIR" lever at "OUTSIDE," "TEMP" lever full for maximum cooling and blower switch at high blower speed.

11. Set engine speed at 2000 rpm.

12. Allow engine to run for 10 minutes, or until stabilized.

NOTE: If at any time during test, compressor head pressure exceeds 375 psi, discontinue test and check the following:

a. Engine cooling system.

b. Restricted receiver and liquid indicator assembly.

c. Air in refrigeration system or overcharge of refrigerant.

d. Insufficient auxiliary fan air on radiator and condenser.

13. At the end of this time record the following:

a. Ambient air at condenser.

b. Wet bulb temperature in auxiliary fan air stream.

c. Compressor head pressure.

d. Refrigerant test fitting gauge pressure.

e. Center outlet temperature.

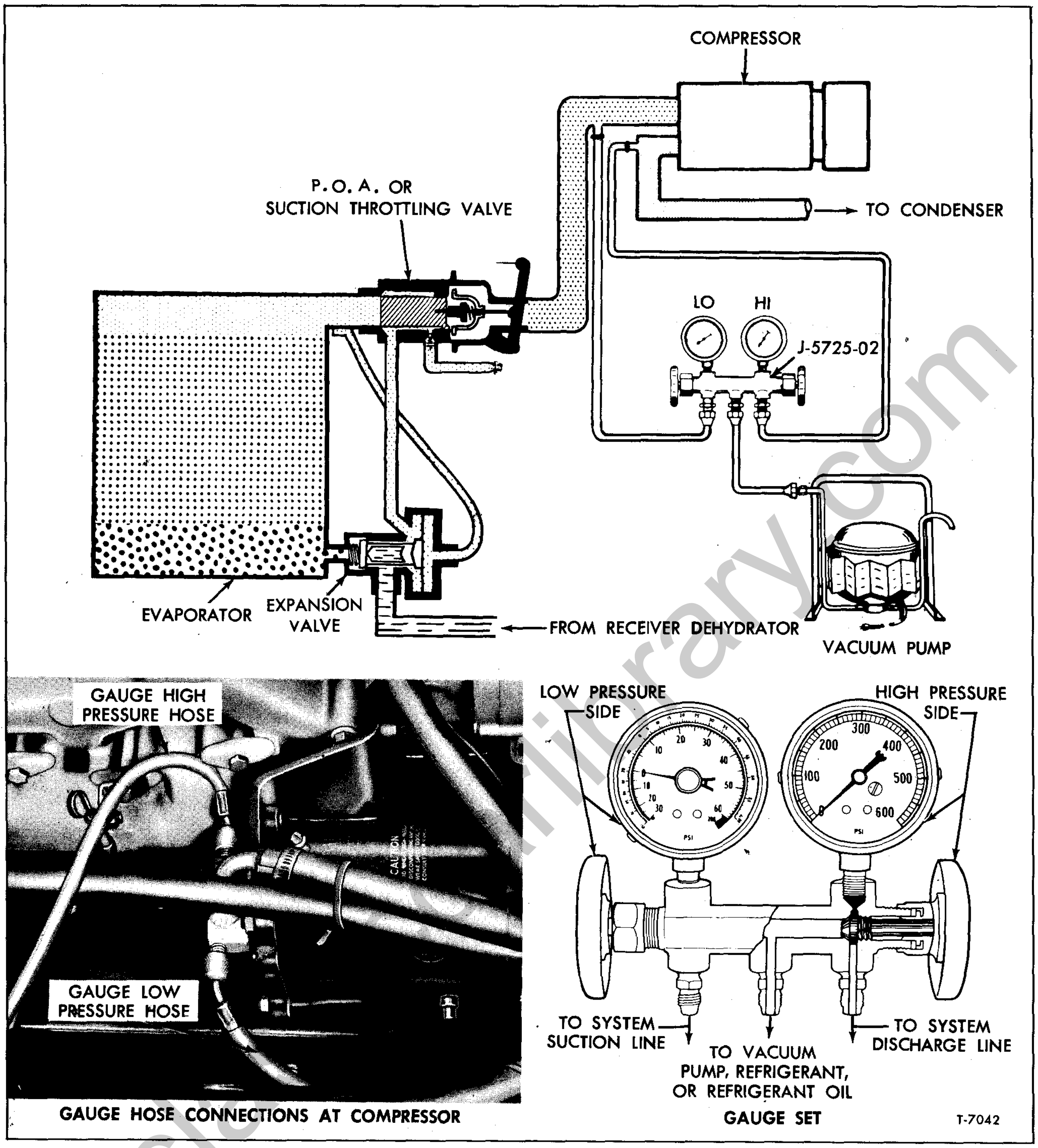


Figure 22—Hook Up of Gauges and Evacuating Pump

Compare previous test with system pressures and temperature shown on "Operational Test Data Chart" (fig. 19). If not within the limits shown, refer to the "Insufficient Cooling Diagnosis Chart" for possible cause of sub-standard performance. Reference should be made in the order listed with head pressure first, if not within "Operational Test Data Chart" limits, then check suction throttling or P.O.A. valve inlet pressure and finally center outlet temperature.

NOTE: For altitude levels at or near sea level, set the suction throttling valve as specified (23

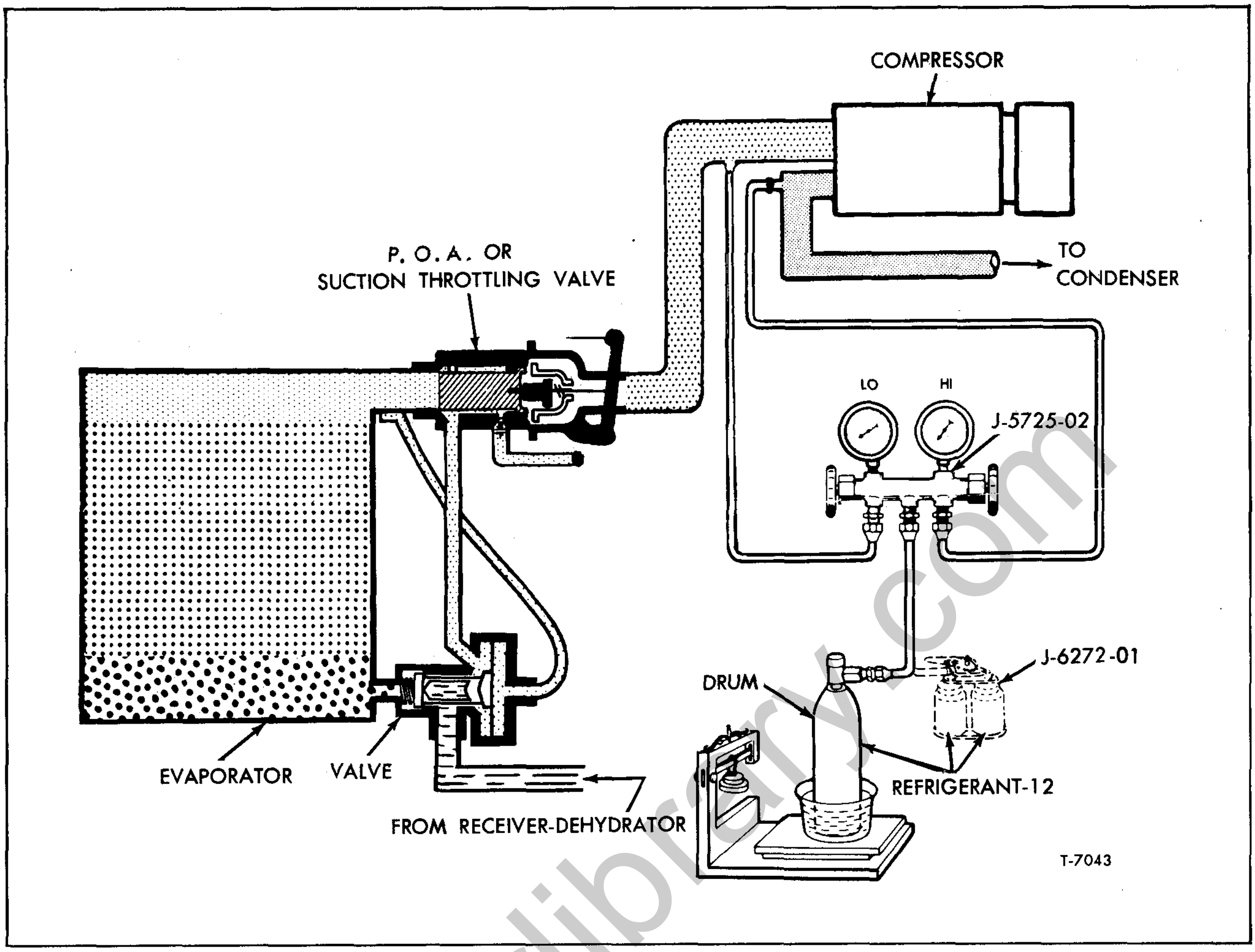


Figure 23—Hook Up of Gauges and Charging Equipment

psig). For higher levels, set valve ½-lb. per-sq.-in. higher for each 1,000 feet of elevation.

14. Remove charging manifold gauge set, test fitting gauge, and install the fitting caps.

DEPRESSURIZING THE SYSTEM

Any time the system is to be opened, it must first be depressurized. Depressurize the system as follows:

NOTE: Install gauge set to compressor gauge fittings (fig. 22) (same connections as shown in figures 21 and 22).

1. Remove caps from gauge fittings at compressor.

2. With both valves on the manifold gauge set (J-5725-04) closed (clockwise), attach manifold hoses to compressor fittings, using (J-5420) Schrader valve adapter at the suction gauge fitting and (J-9459) Schrader valve adapter at the discharge gauge fitting.

3. Crack open the high pressure valve on manifold gauge set to allow slow escape of refrigerant from the system through the manifold gauge set and out the center fitting and hose. (Place end of hose in clean container.) If oil drips from the hose into the container, refrigerant is escaping too rapidly.

4. When hissing ceases (indicating all refrigerant has escaped) close valves on manifold gauge set by turning valve clockwise.

EVACUATING THE SYSTEM

When the refrigeration system is depressurized and opened for service, some air will enter the lines regardless of how quickly the openings are capped. In order to remove this air and as much as possible of the moisture it contains, the complete system must be "evacuated." Evacuating is merely the process of removing all air from the system, thereby creating a vacuum in the system.

CAUTION: Under no circumstances should alcohol be used in the system in an attempt to remove moisture, regardless of the successful use of alcohol in other refrigeration systems.

PREPARATION FOR EVACUATING COMPLETE SYSTEM

1. Check the low pressure gauge for proper calibration, with the gauge disconnected from the refrigeration system. Be sure that the pointer on the gauge indicates to the center of "O." Tap the gauge a few times lihgtly to be sure pointer is not sticking. If necessary, calibrate as follows:

a. Remove the cover from the gauge.

b. Holding gauge pointer adjusting screw firmly with one hand, carefully force pointer in the proper direction in the proper amount to position the pointer through the center of the "O" position. Tap gauge a few times to be sure pointer on gauge is not sticking. Replace gauge cover.

2. If gauge set is not already connected to compressor fittings, connect as follows (refer to fig. 21):

a. Close hand shut-off valves on gauge set by turning clockwise.

b. Remove caps from gauge fittings at compressor.

NOTE: To shorten evacuating and charging time, the valve core in each compressor gauge fitting can be unseated using Tool (J-22132-01). The gauge lines are than connected to the tool fittings. Turn tool knobs counterclockwise to unseat cores.

c. Attach Schrader valve adapter (J-5420) to end of hose from suction valve low pressure gauge and connect this adapter fitted hose to the compressor suction gauge fitting or to Tool (J-22132-01) (if used).

a. Attach Schrader valve adapter (J-9459) to end of hose from compressor gauge and connect this adapter fitted hose to the discharge gauge fitting or Tool (J-22132-01) (if used).

3. Attach a flexible gauge hose to the center fitting of the gauge set and attach the other end of this hose to the vacuum pump (J-5428-02) (fig. 22).

4. The system can now be evacuated.

EVACUATING COMPLETE SYSTEM

1. Turn hand shut-off valve on low pressure gauge of gauge set to the full clockwise (closed) position.

2. Slowly turn valve on high pressure gauge counterclockwise from the full clockwise position, letting any pressure build-up escape completely. Close high pressure valve.

3. Check oil level in vacuum pump (J-5428-02) and add Frigidaire-150 viscosity oil or equivalent, if necessary, to bring to proper level. Make sure dust cap on discharge side of vacuum pump has been removed.

4. Start the vacuum pump and slowly open the low and high pressure sides of the manifold gauge set to avoid forcing oil out of the refrigeration system and the pump. Pressure is now being reduced on both sides of the refrigeration system.

NOTE: If oil is blown from the vacuum pump, it should be refilled to the proper level with Frigidaire-150 viscosity oil or equivalent.

5. Observe low pressure gauge and operate vacuum pump until gauge shows 26-28" vacuum. Continue to run pump for ten additional minutes.

NOTE: In all evacuating procedures the specification of 26-28 inches of vacuum is used. This evacuation can only be attained at or near sea level. For each 1,000 feet above sea level where this operation is being performed, the specification should be lowered by one inch of mercury vacuum.

For Example: At 5,000 feet elevation only 21 to 23 inches of vacuum can normally be obtained.

If vacuum cannot be pulled to the minimum specification for the respective altitude, it indicates a leak in the system, gauge connections or a defective vacuum pump. In this case, it will be necessary to check for leaks as outlined later, after a small amount of Refrigerant-12 has been added to the low side of the system.

a. Turn the hand shut-off valves at the low and high pressure gauge of the gauge set to the full clockwise position with the vacuum pump operating, then stop pump.

b. Connect flexible line from center fitting of the gauge set to refrigerant container (container should be at room temperature).

NOTE: It may be necessary to use reducer fitting (J-8695-18) if attaching flexible hose to drum-type refrigerant container.

c. Open shut-off valve on container and loosen flexible line fitting at center fitting at gauge set so that refrigerant will purge all air from line. Tighten flexible fitting when certain all air has been purged from line.

d. Open suction valve on gauge set. This will allow refrigerant to pass from the container into the system. When pressure stops rising, close suction valve on gauge set and valve at refrigerant container (as refrigerant container is at room temperature, only a small refrigerant charge will enter the system).

e. Using leak detector (J-6084) (fig. 24), check all fittings in the system, compressor shaft seal and on the gauge set for evidence of leakage. When general area of leak has been found with the test torch, a liquid leak detector may be helpful in locating the exact point of leakage. After leak has been corrected, evacuate the system again for 15 to 20 minutes.

6. Turn the hand shut-off valves at the low and high pressure gauge of the gauge set to the full clockwise position with the vacuum pump operating, then stop pump. Carefully check low pressure gauge to see that vacuum remains constant. If vacuum reduces, it indicates a leak in the system or gauge connections. See "NOTE" in Step 5 previously for method of locating leak.

CHARGING THE SYSTEM

The system should be charged only after being evacuated as outlined in "Evacuating The System."

REFRIGERANT DRUM METHOD

1. Connect center flexible line of gauge set to refrigerant drum (fig. 23).

NOTE: It may be necessary to use adapter (J-8695-18) to attach flexible line to refrigerant drum.

2. Place refrigerant drum in a pail of water which has been heated to a maximum of 125°F. (fig. 23).

CAUTION: DO NOT allow temperature of water to exceed 125°F. High temperature will cause excessive pressure and possible softening of the fusible safety plugs in the refrigerant drum. It may not be necessary to use hot water if a large drum is used (over approx. 100 pounds).

3. If line at center gauge fitting has not been purged of air, loosen line at center fitting on gauge set and "crack" valve on refrigerant drum to blow air from line. Retighten line at center fitting and record exact weight of refrigerant tank in water on the scales.

NOTE: When purging a line by cracking a fitting, wrap a cloth around connection to prevent injury due to release of pressurized refrigerant. Also, be sure to wear eye protection.

CAUTION: DO NOT turn refrigerant drum upside down as this would allow liquid refrigerant to enter compressor which may cause damage.

4. Open valve on refrigerant drum and both valves on gauge set to allow refrigerant to flow into the system. Continue charging until the scales show that 3¼ pounds or 4½ pounds of refrigerant has been transferred from refrigerant drum to the system.

NOTE: If full charge cannot be attained, close both valves on gauge set, start engine, place "AIR COND" lever to "ON," the "AIR" lever to "OUTSIDE," and then place "TEMP" lever to full cold position. Open low pressure valve on gauge set slowly and leave open until full charge of 3¼ lbs. of Refrigerant-12 is taken in on Conventional Models and 4½ lbs. on Aluminum Tilt Cabs.

Figure 24—Checking for Refrigerant Leak

CAUTION: Observe high pressure gauge while charging with compressor running. Shut off engine if pressure exceeds 375 psi. A large fan placed in front of the vehicle will help reduce excessively high head pressure.

5. Close both valves on gauge set (high pressure valve will already be closed if charging was completed by running compressor) and close valve on refrigerant drum.

NOTE: If the engine was used to complete the Refrigerant-12 charge into the system, close valve on refrigerant drum to permit compressor to draw any refrigerant left in the line from the drum to the center fitting of the gauge set, then close the low pressure valve on the gauge set.

6. Operate engine at 2,000 rpm with "TEMP" control knob at full cold position and blower control for high speed with "AIR" lever to "OUTSIDE". After ten minutes of operation observe appearance of refrigerant in receiver-dehydrator. If bubbles

are observed, open low pressure gauge valve and valve on refrigerant drum to allow more refrigerant to enter system. Close valve when receiver-dehydrator clears up.

NOTE: If air inlet temperature is below 70°F., when this check is made, bubbles may appear even though the proper amount of refrigerant is in the system. Air inlet temperature must be 70°F., or above to make an accurate check. In no case should the system be charged with more than specified refrigerant.

7. When refrigerant has been injected, continue to operate system and test for proper operation as outlined under "Performance Testing."

8. When satisfied that air conditioning system is operating properly, stop engine, remove gauge set and replace protective caps on compressor fittings.

CAUTION: A considerable amount of refrigerant will collect in the high pressure line, since some of this refrigerant will have condensed into liquid refrigerant. Wrap the high pressure gauge fitting at the compressor with a shop cloth before disconnecting the Schrader valve from the gauge fitting, to prevent injury to personnel.

9. Using leak detector (J-6084), check complete system for leaks, as explained later under "Checking For Leaks."

REFRIGERANT-12 DISPOSABLE CAN METHOD

After having depressurized, repaired (if necessary), and evacuated the refrigerant system, the system may be charged as follows when using Refrigerant-12 disposable cans:

1. Obtain five 1-lb. cans of Refrigerant-12.
2. Mount four cans in J-6272-01 No. 4 Multi-opener or attach J-6271 Fits-All valve (single can opener valve) on one can.

CAUTION: Make sure outlet valve on opener is closed (clockwise) before installing opener.

a. If (J-6272-01) No. 4 Multi-opener is used, raise locking lever, position four cans of refrigerant and force the locking lever down to secure cans and at the same time puncture the top of the can to make it ready for charging.

b. If (J-6271) Fits-All valve is used, back off the valve from the cap top retainer, slip the valve on to the can and turn the valve into the retainer until tight. DO NOT open outlet valve during this operation as turning the valve into the retainer punctures the top of the can to make it ready for charging.

3. Connect center flexible line of gauge set to the fitting on a can opener valve.

NOTE: If line at center gauge fitting has not been purged of air, loosen line at center fitting on gauge set and "crack" valve at can opener (for a second or two) to force air from the line. Retighten line at center fitting.

4. Open valve on No. 4 Multi-opener (or on single can) and also low pressure and high pressure valves on manifold gauge set. Leave can valve open until all refrigerant has entered the refrigeration system. Close valve on can.

a. If the system is charged using single cans and the (J-6271) valve, disconnect valve from can, leaving valve closed to flexible line to the center fitting of the manifold gauge set. Install valve on a new and full disposable can of Refrigerant-12, and repeat until the system is fully charged. (Actually the net weight of refrigerant is 15 ounces per can, therefore it will be necessary to use 3½ to 5 cans. In no case should the system be charged with more than 3¼ pounds of refrigerant on Conventional Cabs or 4½ pounds on Aluminum Tilt Cabs.

If the (J-6271) Fits-All valve for single cans is available, complete charging as explained in 4a. previously.

5. Close valves on manifold gauge set.

6. Operate engine at 2,000 rpm with "TEMP" control knob at full cold position and blower control for high speed with "AIR" knob in "OUTSIDE" position.

NOTE: If air inlet temperature at the condenser is below 70°F., when this check is made bubbles may appear even though the proper amount of refrigerant is in the system. Air inlet temperature must be 70°F., or above to make an accurate check. In no case should the system be charged with more than 3¼ pounds of refrigerant.

7. When refrigerant has been installed, continue to operate system and test for proper operation as outlined previously under "Performance Testing."

8. When satisfied that air conditioning system is operating properly, stop engine, remove gauge set and replace protective caps on suction and discharge fittings.

CAUTION: A considerable amount of refrigerant will collect in the high pressure line, since some of this refrigerant will have condensed into liquid refrigerant. Wrap the high pressure fitting at the compressor with a shop cloth before disconnecting the Schrader valve from the gauge fitting to prevent damage or injury to personnel.

9. Using leak detector (J-6084) (fig. 24), check complete system for leaks as explained later under "Checking For Leaks."

SERVICE STATION METHOD

The (J-8393) Deluxe Portable Air Conditioner Service Station supplies all evacuating and charging equipment assembled into a compact portable unit.

1. Be certain compressor hand shut-off valves are closed to gauge fittings (counterclockwise).
2. Be certain all valves on charging station are closed.
3. Connect high pressure gauge line (with J-9459 attached) to compressor high pressure gauge fitting or to core remover Tool (J-22132-01) (if used).
4. Turn high pressure hand shut-off valve one turn clockwise, and high pressure control (2) one turn counterclockwise (open). Crack open low pressure control (1) and allow refrigerant gas to hiss from low pressure gauge line for three seconds, then connect low pressure gauge line to low pressure gauge fitting on compressor. Place (J-5420) adapter on hose, then attach adapter to gauge fitting or fitting core remover tool.

Filling Charging Cylinder

1. Open control valve on refrigerant container.
2. Open valve on bottom of charging cylinder allowing refrigerant to enter cylinder.
3. Bleed charging cylinder to valve (behind control panel) only as required to allow refrigerant to enter cylinder. When refrigerant reaches desired charge level (3¼ or 4½ lbs.), close valve at bottom of charging cylinder and be certain cylinder bleed valve is closed securely.

NOTE: While filling the cylinder, it will be necessary to close the bleed valve periodically to allow boiling to subside so that refrigerant level in the charging cylinder can be accurately read.

Charging The System
Using Service Station J-8393

1. With charging station installed as previously described, remove low pressure gauge line at compressor.
2. Crack open high (No. 2) and low (No. 1) pressure control valves on station, and allow refrigerant gas to purge from system. Purge slowly enough so that oil does not escape from system along with refrigerant.
3. When refrigerant flow nearly stops, connect low pressure gauge line to compressor.
4. Turn on vacuum pump and open vacuum control valve (No. 3).
5. With system purged as directed previously, run pump until 26-28 inches of vacuum is obtained. Continue to run pump for 15 minutes after the system reaches 26-28 inches vacuum.

NOTE: in all evacuating procedures, the specification of 26-28 inches of mercury vacuum is used. These figures are only attainable at or near sea level. For each 1,000 feet above sea level where this operation is being performed, the specifications should be lowered by one inch.

For Example: 5,000 ft. elevation only 21 to 23 inches vacuum can normally be obtained.

6. If 26-28 inches vacuum (corrected to sea level) cannot be obtained, close vacuum control valve (No. 3) and shut off vacuum pump. Open refrigerant control valve (No. 4) and allow some refrigerant to enter system. Locate and repair all leaks.
7. After evacuating for 15 minutes, add ½-lb. of refrigerant to system as described in Step 6 previously. Purge this ½-lb. and re-evacuate for 15 to 30 minutes. This second evacuation is to be certain that as much contamination is removed from the system as possible.
8. Only after evacuating as directed previously system is ready for charging. Note reading on sight glass of charging cylinder. If it does not contain a sufficient amount for a full charge, fill to the proper level.
9. Close low pressure valve on charging station. Fully open station refrigerant control valve (No. 4) and allow all liquid refrigerant to enter system. When full charge of refrigerant has entered system, turn off refrigerant control valve (No. 4) and close both hand shut-off valves.
10. If full charge of refrigerant will not enter system, close high pressure control and refrigerant control valves. Start engine and run at slow idle with compressor operating. Crack refrigerant control valve (No. 4) and low pressure control on station. Watch low side gauge and keep gauge below 50 psi by regulating refrigerant control valve. Closing valve will lower pressure. This is to prevent liquid refrigerant from reaching the compressor while the compressor is operating. When required charge has entered system, close refrigerant control valve and close low pressure control.
11. System is now charged and should be performance tested before removing gauges.

ADDING REFRIGERANT (SMALL AMOUNT)

The following procedure should be used in adding small amounts of refrigerant that may have been lost by leaks, or while opening system for servicing the compressor. Before adding refrigerant to replace that lost by leaks, check compressor oil level and add oil if necessary. See "Adding Oil" later.

NOTE: This procedure will only apply if air inlet temperature is above $70^{\circ}F.$, at condenser.

1. Remove caps from compressor gauge fittings. Attach gauge set to gauge fittings, making sure Schrader adapter is between low pressure gauge hose and suction gauge fitting, and between high pressure gauge hose and discharge gauge fitting.

2. Start engine, turn air conditioning temperature control to full cold position, blower control for high speed, and also move "AIR" lever to "OUTSIDE." Operate for ten minutes at 2,000 rpm to stabilize system.

3. Observe the refrigerant through the sight glass of the receiver-dehydrator with the system operating, to see if there are any bubbles evident.

a. If no bubbles are evident, then bleed system slowly through the discharge valve until bubbles appear in the receiver-dehydrator sight glass. Add one pound of refrigerant as explained under "Charging The System."

b. If bubbles are visible in the receiver-dehydrator sight glass with the "TEMP" control knob at the full cold position and the blower at high speed, it indicates partial or complete plug in a line, or a shortage of refrigerant, or both. Correct condition. Add refrigerant as explained below until the sight glass clears, then add another one pound of refrigerant.

4. Attach flexible hose from center fitting of gauge set loosely to refrigerant drum or on disposable can valves. Open high and low pressure valves on the gauge set slightly to purge pressure gauge lines of air. Tighten fitting of refrigerant drum or can, when satisfied that all air has been removed from gauge lines. Close (clockwise) both hand shut-off valves of gauge set.

5. Partially charge system.

a. Refrigerant-12 Drum Method:

(1) Place pail containing hot water that does not have a temperature exceeding 125 F., on scales, place refrigerant drum in pan containing water, note weight, and only open low pressure valve on gauge set.

(2) Start engine, move "Temp" control knob to full cold position, and place blower control for high speed. Operate engine for ten minutes at 2,000 rpm to stabilize system.

(3) With compressor operating, slowly open valve on refrigerant drum and allow refrigerant to flow into system (through manifold gauge set) until liquid indicator clears up and immediately shut off valve at gauge set or on refrigerant drum. Check weight of refrigerant drum and pail of water. Then slowly open valve on gauge set (or refrigerant drum) and add one more pound of refrigerant. Note total amount of refrigerant added.

b. Refrigerant-12 Disposable Can Method (15 Oz. Per Can):

(1) Make sure the outlet valve on the (J-6271) Fits-All valve is fully clockwise and attach the (J-6271) Fits-All valve to a "1-lb." can of refrigerant as follows: Back off the valve from the top of the retainer, slip the valve onto the can and turn the valve into the retainer until tight. DO NOT accidentally open outlet valve during this operation as turning the valve into the retainer punctures the top of the can to make it ready for charging.

(2) Connect center flexible line of gauge set to the fitting on the valve.

(3) Start engine, place "TEMP" control knob to full cold position and blower control for high speed with "AIR" knob in "OUTSIDE" position. Operate engine for ten minutes at 2,000 rpm to stabilize system.

(4) With compressor operating, slowly open valve on refrigerant can and allow refrigerant to flow into system (through manifold gauge set) until liquid indicator clears up and immediately shut off valve at gauge set and on refrigerant can. Check weight of can and valve assembly and record.

(5) Add an additional one-pound of refrigerant by adding refrigerant from the can just weighed until can is empty.

6. Close valves at refrigerant drum or can.

7. Test for leaks and make operational check of system as outlined under "Performance Testing."

CHECKING COMPRESSOR OIL LEVEL AND ADDING OIL

The refrigeration system with the six-cylinder axial compressor requires 11 fluid ounces of 525 viscosity oil. After the system has been operated, oil circulates throughout the system with the refrigerant. Hence, while the system is running, oil is leaving the compressor with the high pressure gas and is returning to the compressor with the suction gas.

NOTE: The oil level in the compressor should not be checked as a matter of course, such as is done to the truck engine crankcase.

CHECKING COMPRESSOR OIL LEVEL

Normally, the compressor oil level needs to be checked only when there is evidence of a major oil loss such as a broken hose or fitting, a leaking compressor seal, or collision damage. However, if low compressor oil level is suspected, a quick check may be performed as follows:

1. Operate engine at idle with air conditioning on maximum cooling for approximately ten minutes.

2. Turn off engine and momentarily crack open oil drain plug on bottom of compressor allowing a slight amount of oil drain out. Retighten plug.

3. Again, slightly crack open plug. If oil comes out, the compressor has the required amount of oil. The oil may appear foamy which is normal.

To further check the compressor oil charge, should previous check indicate insufficient oil, it will be necessary to remove compressor from vehicle and measure oil as described following:

ADDING OIL TO COMPRESSOR

When refrigerant system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor. The amount of oil to put back into the compressor is found as follows. DO NOT add any more oil than is necessary or maximum cooling will be reduced.

1. Remove the compressor and place in a horizontal position with the compressor drain plug downward, drain compressor in an empty graduated bottle, measure the amount of oil and discard this oil.

2. If the quantity of oil measured is more than 4 fluid ounces, replace into the compressor the same amount of clean oil as the oil drained, plus the following amount for the refrigeration system component being changed:

a. Evaporator - 3 fluid ozs.

b. Condenser - 1 fluid oz.

c. Receiver-dehydrator assembly - 1 fluid oz.

Neglect any fluid oil coating loss in case of line change.

3. If the oil quantity drained from the compressor is less than 4 ounces, replace into the compressor 6 fluid ounces of clean oil, plus the amount shown previously for the respective component replacements.

4. Replace compressor and system components.

5. Evacuate, charge and perform operational test.

CHECKING FOR LEAKS

Leak detector (J-6084) (fig. 24) used for checking for leaks in system, is a gas-operated torch-type leak detector using a replaceable cylinder.

ASSEMBLING AND LIGHTING THE UNIT

1. Remove dust cap from cylinder.

2. Close valve knob on detector unit.

3. Thread detector unit onto top of fuel cylinder. Tighten finger-tight.

4. Attach search hose assembly to detector unit (fig. 24).

5. Open control valve until slight hiss of gas is heard, then light gas at opening in chimney.

CAUTION: DO NOT use lighted detector in any place where combustible or explosive gases, dusts, or vapors may be present.

6. Adjust the flame until the desired volume is obtained. A pale blue flame approximately 3/8" above the reaction plate is best for detecting leaks.

NOTE: The reaction plate will be heated to a cherry red.

CORRECTION FOR YELLOW FLAME

If the flame is yellow, insufficient air is being inspirated or the reaction plate is dirty. Insufficient air may be caused by:

1. Obstructed or partially collapsed suction tube.

2. Dirt or foreign substance in burner tube.

3. Dirty or partially clogged orifice.

Blowing air through the suction tube and back through the detector will usually clear dirt or foreign matter. If a yellow flame is caused by dirty reaction plate, allow the flame to burn for several minutes. This will usually burn the plate clean. If an oxide film appears on the reaction plate from continued use, it will reduce the sensitivity of the detector. This may be remedied by removing the plate and scraping the surface gently with a knife.

TO CLEAN ORIFICE

1. Never attempt to clean orifice by passing anything through the hole.

2. Unthread burner head assembly from burner tube. This will expose orifice block which is inserted into the end of the tube.

3. Remove orifice block from tube.

4. Reverse orifice block and replace against burner tube; thread burner head onto burner tube (hand tight), then open valve quickly, admitting several short blasts.

5. To reassemble, unthread burner head, insert orifice block into burner tube, and thread burner head onto burner tube with a wrench to form a gas-tight joint.

Replacement parts can be obtained from Kent-Moore Corp., Detroit, Michigan.

CHECKING FOR REFRIGERANT LEAKS

After the leak detector flame is adjusted, check for refrigerant leaks in an area having a minimum amount of air flow in the following manner (see fig. 24):

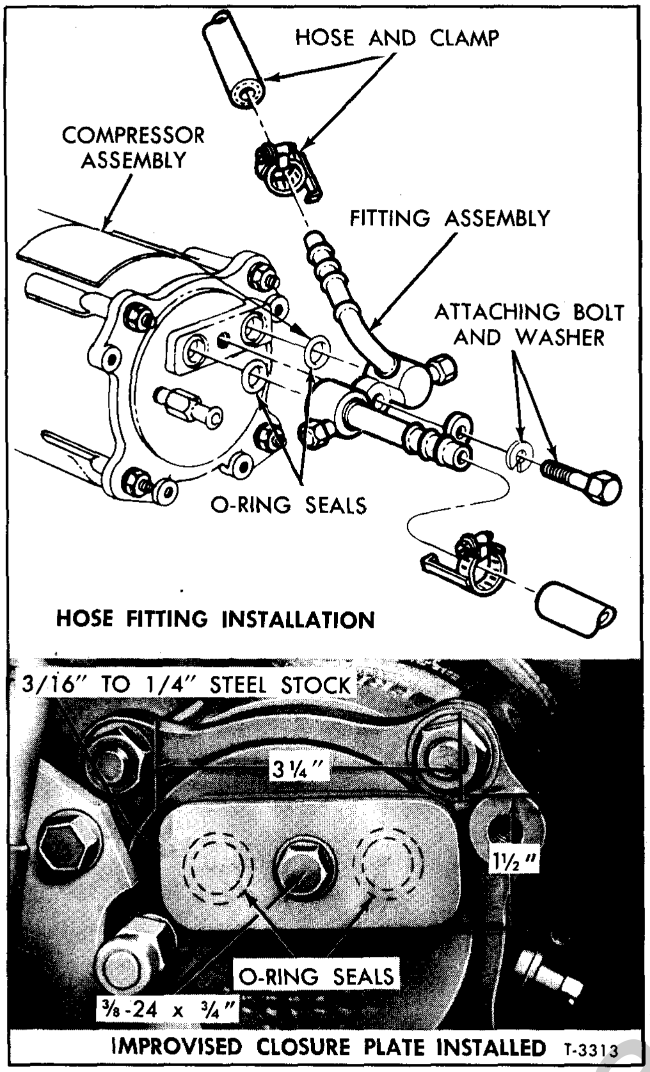


Figure 25—Compressor Fitting Installation (Typical)

Explore for leaks by moving end of sampling tube around all connections and points where a leak may be. Check around bottom of connections, since Refrigerant-12 is heavier than air and will, therefore, be more apparent at bottom of fitting.

> **CAUTION: DO NOT breathe the fumes and black smoke that are produced if the leak is a big one. They are poisonous. Any time an open flame is used near a vehicle there is a certain amount of danger. Although the torch flame is small and well protected, it is recommended that fire extinguisher be close at hand for any emergency that might arise.**

The color of the flame will turn to a yellow-green when a small leak is detected. Large leaks will be indicated by a change in color to brilliant blue or purple. When the suction hose is moved away from the leak the flame will clear to an almost colorless pale blue again.

LIQUID-TYPE LEAK DETECTORS

There are a number of fittings and places throughout the air conditioning unit where a liquid leak detector solution may be used to pinpoint leaks.

By merely applying solution to the area with the swab that is usually attached to the bottle cap, bubbles will form within seconds if there is a leak.

For confined areas, such as sections of the evaporator and condenser, the torch-type detector is the only practical kind which should be used for determining leaks.

ELECTRONIC LEAK DETECTOR

An electronic leak detector for detecting refrigerant leaks is also available. Instructions for operation of this type detector are supplied with the unit.

REPLACING COMPRESSOR

The compressor removed must be closed immediately. See lower View of figure 25 which shows a closure plate which can be improvised and installed as shown.

If the system has been or can be operated for more than two minutes, circulation of oil from the compressor to other components of the system will require adjustment of the oil charge in the new compressor as explained previously, under "Adding Oil To Compressor."

After draining and measuring the oil from the crankcase, the amount that has migrated to other parts of the system can be determined by subtracting the amount drained from the original oil charge of 11 fluid ounces. The amount of oil equal to this loss shall be drained from the new compressor assembly before it is installed.

COMPRESSOR SEAL

The existence of slight amounts of oil in the immediate area surrounding the compressor is NOT necessarily an indication of a leaking seal. It must be remembered that all moving parts need lubrication. For this reason, the compressor is so designed to allow a slight flow of oil into the areas of the compressor beyond the seals. Since the compressor components are rotated at high speeds, some of this oil may be thrown off the rotating parts. Consequently, do not replace compressor seal until the system is properly checked for leaks.

If no leak is found in the seal area, do not replace seal.

An improved tool (J-22974) is now available to aid in replacing compressor shaft seal. This tool slides on shaft and mates flush with shaft step and provides an even surface for seal to slide past without danger of hang-up during seal installation. Tool (J-22974) replaces formerly used tool (J-21303).

REPLACING AN OPERABLE COMPRESSOR

After idling compressor (on vehicle) to be replaced for 10 minutes at 1500-2000 engine rpm, at maximum refrigeration and blower at high speed: (DO NOT add any more oil to the compressor than is necessary or maximum cooling will be reduced.)

1. Compressor replaced with service compressor assembly.

a. Remove compressor and place in a horizontal position with drain plug downward, drain compressor, measure quantity of oil drained and then discard it.

b. Drain oil from replacement compressor and save it.

c. (1) If amount of oil drained in "a." previously is more than 4 ozs., place into the new compressor the same amount of oil drained from the replaced compressor.

(2) If amount of oil drained in "a." previously is less than 4 ozs., place 6 ozs. of oil in the replacement compressor.

d. Install compressor.

2. Compressor replaced with a field repaired (overhauled) compressor.

a. Proceed as in Step 1 previously, and then add one extra ounce of oil. (More oil is retained in a drained compressor than one that has been rebuilt.)

REPLACING AN INOPERATIVE COMPRESSOR

In the case when it is not possible to idle the compressor to be replaced to effect oil return to it the following will apply. DO NOT add any more oil than is necessary as maximum cooling will be reduced.

1. Remove compressor from vehicle, drain and measure the oil.

2. If amount drained in Step 1 previously is more than 1½ fluid ozs., subtract this amount drained from the original oil charge of 11 ozs., to obtain "oil loss." Take the new compressor assembly and drain from it the amount of "oil loss" above; provided the refrigeration system shows no evidence of a major leak, indicating that little or no oil has been lost from the system. (Minor leak indicating very slow leakage.)

3. If oil drained in Step 1 previously contains any foreign material such as chips, or there is evidence of moisture in the system, replace the receiver-dehydrator assembly and flush all component parts, or replace if necessary. After flushing refrigeration system in this manner, the full oil charge should be left in the new service compressor or 11 ozs., installed in an overhauled or repaired compressor.

COMPRESSOR REMOVAL

1. Connect the high and low pressure gauge lines from the gauge set to the respective connections on the old compressor on the vehicle. Be sure valves on gauge set are fully clockwise to close gauge set to center fitting, and that a (J-5420 or J-9459) Schrader adapter is between low pressure hose and suction gauge fitting, and also at the discharge gauge fitting.

2. Remove the flare nut from center connection on gauge manifold or the plug in the gauge line attached to the center connection. Wrap the line at the outlet with a cloth to protect persons and vehicle surfaces from oil or refrigerant.

3. Slowly depressurize refrigeration system as instructed previously under "Depressurizing The System."

4. While system is depressurizing, remove (if desired) clutch assembly and coil from old compressor. If parts are not oil soaked and are in good condition, lay them aside on a clean surface as they may be installed on the new compressor.

5. After the system is completely depressurized, very slowly loosen screw which retains compressor fittings assembly to compressor (see fig. 25). As screw is being loosened, work fittings assembly back and forth to break seal and carefully bleed off any remaining pressure.

CAUTION: High pressure may still exist at the discharge fitting. If this pressure is released too rapidly there will be a considerable discharge of refrigerant and oil.

6. When all pressure has been relieved, remove fittings assembly and O-ring seals.

7. Immediately cover compressor openings. A simple way is with a plate (similar to the one on new compressor) which can be attached with fittings assembly screw, using the O-rings to provide a seal. See low portion of figure 25.

8. Disconnect compressor clutch coil wire and remove compressor mounting plates to bracket bolts, front and rear.

9. Loosen brace and pivot bolts and detach drive belt.

10. Remove nuts and bolts attaching compressor to mounting brackets. Remove compressor from vehicle (figs. 26 through 29).

11. If there is any possibility that broken parts from the compressor got into the discharge line or

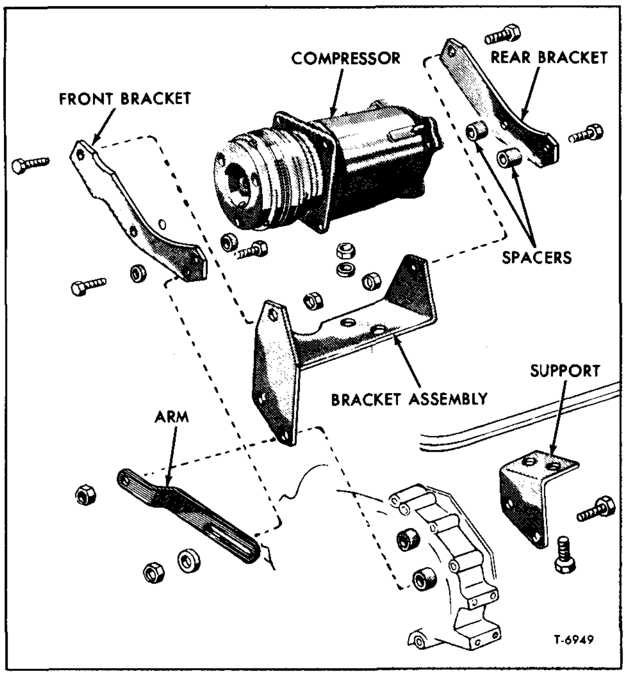


Figure 26—Compressor Mounting (6-71 Alum. Tilt Cab Model)

the condenser, all refrigeration system parts should be cleaned and a new receiver-dehydrator assembly should be installed.

12. Drain all oil from compressor just removed in a clean dry container and replace compressor drain plug screw. Measure amount of oil drained. See "Checking Compressor Oil Level and Adding Oil" previously.

COMPRESSOR INSTALLATION

NOTE: Before installing a new compressor, rotate compressor shaft four or five times. This permits proper lubrication of compressor seal over all its surface. Before compressor clutch is mounted to the new compressor, wipe the front face of the compressor thoroughly with a clean dry cloth and, if necessary, clean front of compressor with a solvent to remove any excess oil. Cleaning compressor in this manner will prevent any oil from being thrown onto the clutch surfaces which would cause slippage and eventual clutch failure.

1. Stamp refrigerant charge of the refrigerant system on new compressor in space on plate provided for this information.

NOTE: Follow procedure for replacing oil in new compressor explained previously under "Removing Malfunctioning Compressor and Installing New Compressor."

2. Install new compressor to engine (figs. 26 through 29), leaving compressor fittings opening cover plate on the compressor.

3. Remove cover plate over compressor openings very slowly to bleed off pressure.

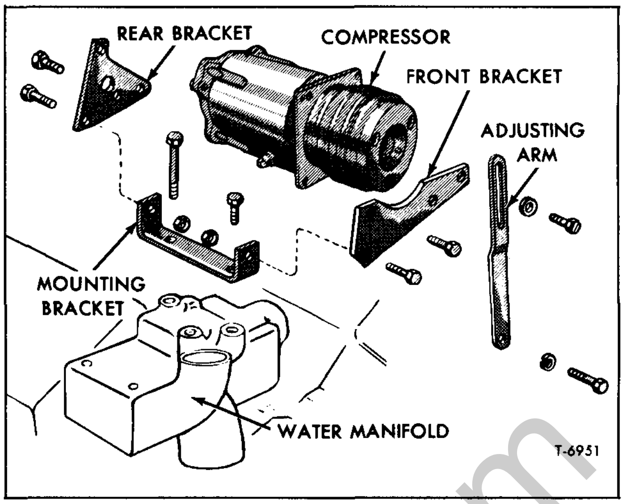


Figure 27—Compressor Mounting (V8 Alum. Tilt Cab Model)

CAUTION: New compressors are charged with a mixture of nitrogen and Refrigerant-12 and 11 fluid ozs. of Frigidaire-525 viscosity oil. If the cover is removed too rapidly, the oil will be blown out violently with the sudden release of pressure.

4. Install the connector assembly to the compressor rear head, using new O-rings.

5. Connect the electrical lead to the coil, then install and adjust compressor drive belt.

NOTE: Inspect compressor drive belt. Check and adjust USED V-belt tension 80 to 90 pounds on belt tension gauge (J-23573) and 120 to 130 pounds on NEW belts.

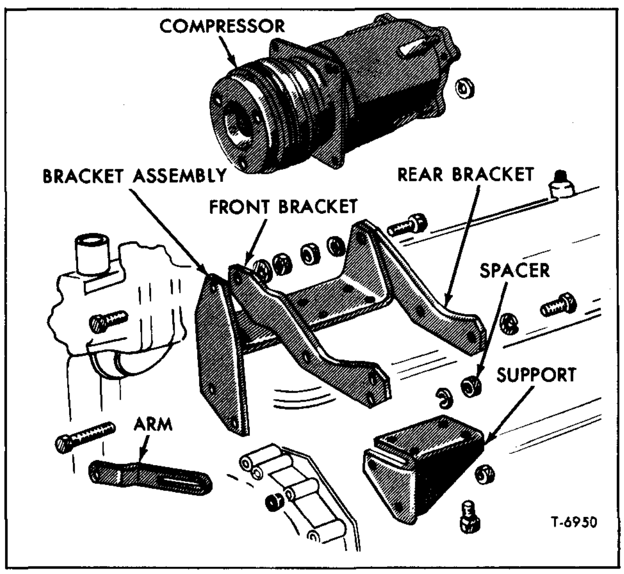


Figure 28—Compressor Mounting (6-71 Conv. Cab Model)

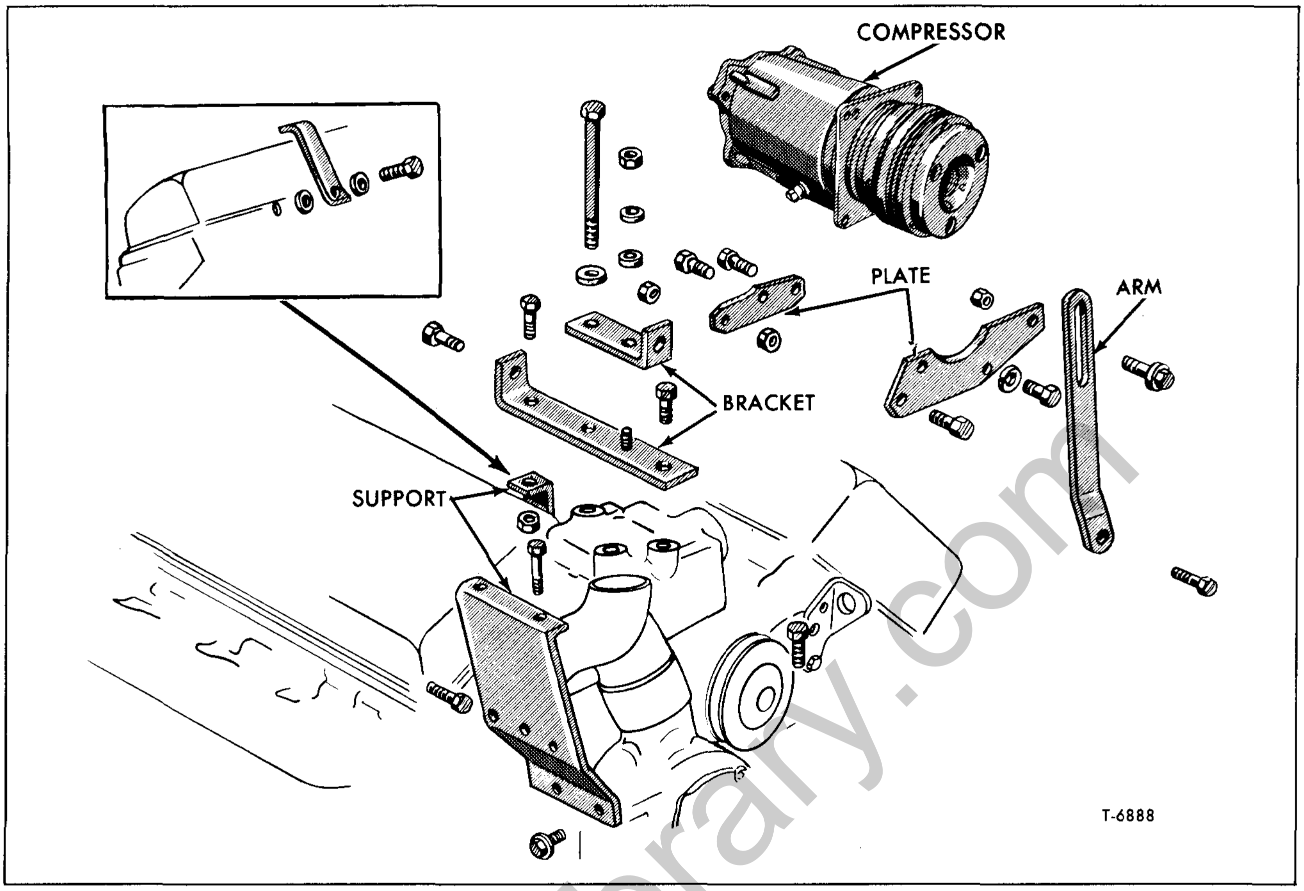


Figure 29—Compressor Mounting (V8 Conv. Cab Model)

Check and adjust USED Poly-V belt tension 64 to 74 pounds on belt tension gauge (J-23586) and 84 to 94 pounds on NEW belts.

Gauge measurement should be taken at greatest span between pulleys. For further details refer to ENGINE COOLING (SEC. 6K) of this manual.

6. Install coil and clutch parts if not already installed.
7. Evacuate, charge, and make a test of system as explained previously under "Performance Testing."
8. Leak test the system and check for proper operation.

SERVICING LEAKING SEALS AND HOSES

When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor if oil was sprayed in copious amounts due to severe leaks or broken lines. DO NOT add any more oil than is necessary or maximum cooling will be reduced. See "Checking Compressor Oil Level and Adding Oil" previously.

1. Replace leaking seal, hose, or line. See figure 30 for proper positioning of hose and hose clamp.

NOTE: The initial clamp screw torque is 35 to 42 inch-pounds. After short period of time, torque may drop off as low as 10 inch-pounds. Final torque the clamp screw to 30-35 inch-pounds.

2. Evacuate, charge, and make performance test.

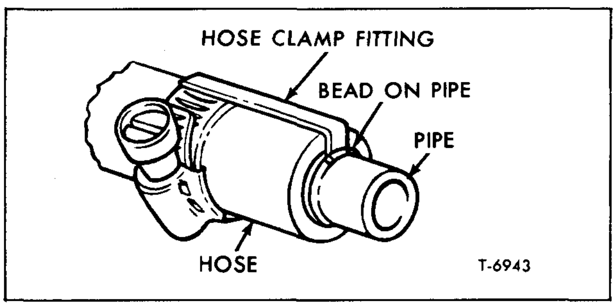


Figure 30—Hose and Clamp Properly Installed

CONDENSER ASSEMBLY REPLACEMENT

NOTE: When refrigeration system components other than the compressor are replaced, compressor must also be removed and oil drained from compressor if oil was sprayed in copious amounts. See "Checking Compressor Oil Level and Adding Oil" explained previously.

1. Depressurize the refrigeration system.
2. Remove radiator grille or tilt the cab.
3. Remove compressor discharge hose clamp at condenser inlet.
4. Remove hose from condenser inlet. Plug openings.
5. Disconnect hex nut connection at condenser outlet, then plug openings.
6. Remove four condenser assembly retaining bolts and remove condenser.
7. Replace by reversing the above procedures, using a new rubber O-ring seal well lubricated with clean compressor oil at line connection.
8. Evacuate and charge system.
9. Make a performance test.

RECEIVER-DEHYDRATOR ASSEMBLY REPLACEMENT

NOTE: When refrigeration system components other than compressor are replaced, the compressor must also be removed and oil drained from compressor if oil was sprayed in copious amounts due to leaks or collision damage to receiver-dehydrator. See "Checking Compressor Oil Level and Adding Oil" explained previously.

1. Depressurize the system.
2. Disconnect inlet and outlet connections of receiver at receiver-dehydrator assembly and plug openings.
3. Loosen the receiver-dehydrator assembly clamp screws and remove assembly.
4. Replace the receiver-dehydrator assembly by reversing the previous procedures, using new rubber O-ring seal, well lubricated with clean compressor oil, at line connection.
5. Evacuate complete system.
6. Charge complete system.
7. Make performance test.

CONSOLE ACCESS PANEL AND HEATER COVER REPLACEMENT (ALUMINUM TILT CAB)

1. Remove passenger seat and platform as previously described in "Cab and Sleeper Compartment" in "ALUMINUM TILT CABS" (SEC. 1D).
2. Loosen screws that retain panel access cover to panel reinforcement brace, console panel, and heater cover. Remove access cover from cab.
3. Loosen screws retaining heater cover to panel reinforcement and console panel. Remove air conditioning outlets from air distributor. Remove heater cover from cab.
4. To install covers simply reverse removal procedures. Be sure seals located on edges of access panel and heater covers are in place before tightening screws.

EXPANSION VALVE REPLACEMENT (ALUMINUM TILT CAB)

(Refer to Figures 1 and 3)

NOTE: When refrigeration system components other than compressor are replaced the compressor must also be removed and oil drained from compressor, if oil was sprayed in copious amounts due to leaks or collision damage to valve. See "Checking Compressor Oil Level and Adding Oil" explained previously.

REMOVAL

1. Remove access panel and heater cover as described previously in this section, under "Console Access Panel and Heater Cover Replacement."
2. Depressurize the system.
3. Loosen the clamp retaining the high pressure lines to the expansion valve.
4. Disconnect the capillary bulb from the evaporator outlet pipe (located just below the P.O.A. valve).
5. Disconnect the equalizer line from the P.O.A. valve and cap the connections.
6. Disconnect the expansion valve inlet and outlet connections and cap the lines.
7. Remove expansion valve-to-bracket mounting screw and remove expansion valve. BE CAREFUL NOT TO KINK CAPILLARY BULB TUBE.

INSTALLATION

1. Mount the expansion valve to the bracket on the side of main heater housing.
2. Connect the inlet and outlet connections to expansion valve. Tighten inlet pipe clamp.

NOTE: When connecting the inlet and outlet connections to the expansion valve, be sure to use new O-ring seals, well lubricated with clean compressor oil, at each fitting connection.

3. Connect the equalizer line to the P.O.A. valve and mount the capillary bulb to the evaporator outlet pipe (locate just below the P.O.A.).

NOTE: Be sure to wrap insulating tape around installed capillary bulb and evaporator outlet pipe.

4. Evacuate and charge the system. Check performance.
5. Install access panel and heater cover as described previously in this section.

EXPANSION VALVE REPLACEMENT (CONVENTIONAL CAB)

NOTE: When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor, if oil was sprayed in copious amounts due to leaks or collision damage to valve. See "Checking Compressor Oil Level and Adding Oil" explained previously.

REMOVAL

1. Depressurize the system.
2. Drain the cooling system.
3. Remove the evaporator and heater core unit from under dash as directed later under "Evaporator, Heater Core and Blower Replacement."
4. Remove the upper cover from lower unit (fig. 11).
5. Disconnect expansion valve capillary tube bulb at evaporator outlet pipe.
6. Disconnect expansion valve equalizer line at suction throttling valve.
7. Disconnect thermostatic expansion valve inlet and outlet connections carefully, as some pressure may still exist, and plug openings.
8. Remove expansion valve, noting amount of oil that drains from fittings, and plug openings.

INSTALLATION

1. Install expansion valve using new rubber O-ring seals, well lubricated with clean compressor oil, at each fitting connection.
2. Install upper cover to lower unit.
3. Install evaporator and heater core unit under sash as directed later under "Evaporator, Heater Core, and Blower Replacement."
4. Evacuate and charge system.
5. Make a performance test.

P.O.A. VALVE REPLACEMENT (ALUMINUM TILT CAB)

(Refer to Figures 1 and 3)

NOTE: When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor. if oil was sprayed in copious amounts due to leaks or collision damage to core. See "Checking Compressor Oil Level and Adding Oil" explained previously.

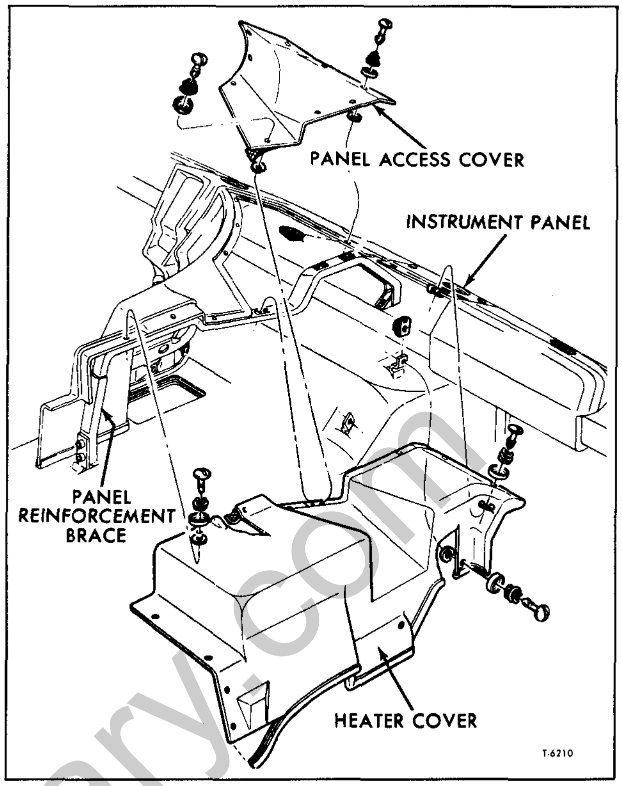


Figure 31—Console Access Panels

REMOVAL

1. Remove access panel and heater cover as described previously in this section, under "Console Access Panel and Heater Cover Replacement."
2. Depressurize the system.
3. Remove evaporator oil bleed line and expansion valve equalizer line. Cap the connections.
4. Remove retaining clamp screw and loosen P.O.A. valve outlet pipe clamp mounting screw.
5. Remove P.O.A. valve inlet and outlet connections and remove P.O.A. valve. Cap the open tubes.
6. Remove clamp from P.O.A. valve.

INSTALLATION

1. Position clamp on P.O.A. valve and connect inlet and outlet connections.

NOTE: Be sure to use new O-ring seals well lubricated with clean compressor oil at both the inlet and outlet connections to the P.O.A. valve.

2. Secure P.O.A. valve clamp and outlet line clamp.
3. Connect the evaporator oil bleed line and expansion valve equalizing line to the P.O.A. valve.
4. Wrap inlet and outlet tubing and connections with insulation tape. Be sure capillary bulb from expansion valve (mounted on evaporator core outlet tube), is covered with insulation tape.

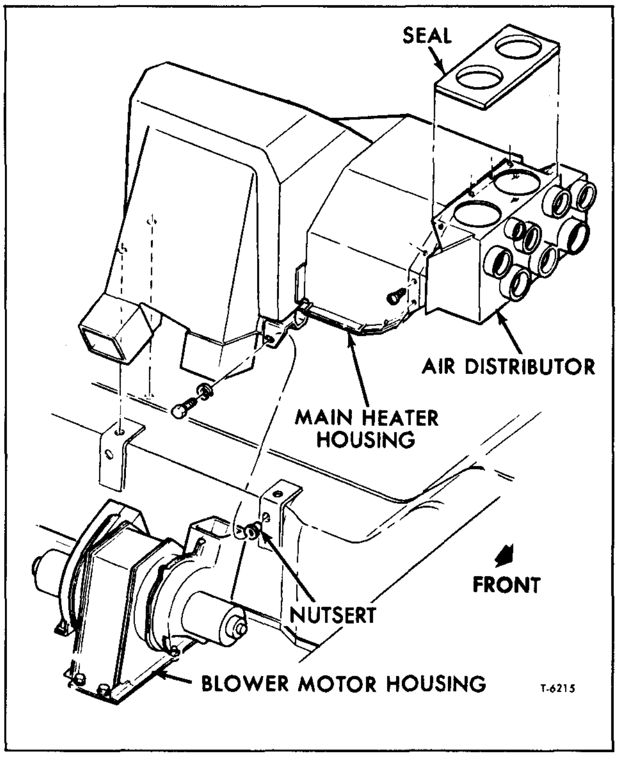


Figure 32—Blower Motor Assembly, Main Heater Housing, and Air Distributor Assembly

5. Evacuate and charge the system. Check performance.
6. Install access panel and heater cover as described previously in this section.

SUCTION THROTTLING VALVE REPLACEMENT (CONVENTIONAL CAB)

NOTE: When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor if oil was sprayed in copious amounts due to leaks or collision damage to core. See "Checking Compressor Oil Level and Adding Oil" explained previously.

REMOVAL
1. Depressurize the refrigeration system.
2. Disconnect expansion valve equalizer line at the suction throttling valve plug openings. (fig. 2).
3. Disconnect suction valve to compressor hose elbow.
4. Disconnect suction valve from evaporator outlet. Remove two bracket attaching cap screws, then remove valve.

INSTALLATION
1. Replace the suction throttling valve by connecting equalizer line, compressor hose, and evaporator outlet, using new rubber O-ring seals, well lubricated with compressor oil, at each connection.
2. Install bracket with two attaching screws.
3. Evacuate complete system.
4. Charge complete system.
5. Make a performance test.

MAIN HEATER HOUSING AND AIR DISTRIBUTOR REPLACEMENT (ALUMINUM TILT CAB)

REMOVAL
(Refer to Figs. 3, 4, and 32)
1. Remove access panel and heater cover as described previously in this section, under "Console Access Panel and Heater Cover Replacement."
2. Depressurize the refrigeration system and drain the engine coolant.
3. Disconnect battery ground cable or pull master circuit breaker switch on instrument panel.
4. Disconnect inlet line to expansion valve, and outlet lines to P.O.A. valve. Cap all openings.
5. Disconnect coolant lines from main heater core and sleeper heater core (when used).
6. Disconnect electrical leads from blower motors and air conditioning switch, mounted on air distributor. Then move wiring harness out of position so as not to interfere with heater housing removal.
7. Disconnect all heating and cooling control cables. Label each with colored tape to assure proper installation.
8. On models equipped with sleeper compartment heater, lift-up mattress and plywood support, then loosen plastic clamps retaining sleeper ducts to sleeper heater outlets. Note that plastic clamps are located immediately to the rear of sleeper compartment bulkhead.
9. Loosen plastic clamps retaining heater and defroster duct hoses to air distributor assembly.
10. Remove bolts that retain main heater housing and sleeper heater (when used) to engine tunnel. Remove sealing compound, drain tube, and clamp below tunnel floor.
11. Visually inspect to determine if other equipment, lines, cables, brackets, or attaching parts must be removed to permit removal of the main heater housing and air distributor assembly.

NOTE: It may be necessary to loosen screws at both ends of panel reinforcement brace to provide additional clearance for removal of main heater housing and air distributor assembly (fig. 31).

12. Using an assistant, carefully remove main heater housing and air distributor, plus sleeper heater (when used) from inside cab.
13. If desired, air distributor and sleeper heater can be removed from main heater housing.

If air distributor is removed from main heater housing, during assembly use a sealer at the mating surfaces between the two components to prevent air leaks.

INSTALLATION

1. With the aid of an assistant, carefully position main heater housing and air distributor assembly in the cab on the engine tunnel.

2. Install bolts that retain main heater housing and sleeper heater (when used) to engine cover.

3. Attach heater and defroster hoses to air distributor. Retain hoses in position with plastic clamps.

4. On models equipped with sleeper compartment heater, lift up mattress and plywood support, then secure sleeper ducts to sleeper heater outlets with plastic clamps.

5. Connect all heating and cooling control cables (refer to figs. 4 and 6).

NOTE: Each control cable is equipped with a threaded sleeve which can be adjusted to assure proper cable operation.

6. Connect electrical leads to air conditioning switch mounted on air distributor and blower motors

7. Attach coolant lines to main heater core and sleeper heater core (when used).

8. Connect the refrigerant lines to expansion valve and P.O.A. valve.

NOTE: Be sure to use new O-ring seals which are well lubricated with clean compressor oil at refrigerant line connections.

9. Connect battery ground cable.

10. Evacuate and charge the system. Refill cooling system, Check performance of A/C and heating systems.

11. Install access panel and heater cover as described previously in this section.

EVAPORATOR HEATER CORE ASSEMBLY REPLACEMENT (CONVENTIONAL CAB)

(Refer to Figure 11)

NOTE: When refrigeration system components other than the compressor are replaced, the compressor must also be removed and oil drained from the compressor, if oil was sprayed in copious amounts due to leaks or collision damage to valve. See "Checking Compressor Oil Level and Adding Oil" explained previously.

1. Depressurize the system.
2. Drain coolant.
3. Disconnect heater hoses at cowl.
4. Disconnect air distributor tube from blower.
5. Disconnect all heating and cooling control cables. Also, disconnect blower motor ground wire at dash.
6. Disconnect refrigerant hoses from unit.
7. At base of unit, pull the drain tube from floor opening.
8. Remove four screws which attach unit to right side cowl. There are two at the top and bottom of unit.
9. At front of cowl remove single attaching bolt. Carefully remove unit from cab.
10. Replace evaporator unit and blower motor duct assembly by reversing previous procedures.
11. Evacuate and charge system.
12. Make a performance test.

COLLISION SERVICE

The severity and circumstances of the collision will determine the extent of repair required. Good judgment must be used in deciding what steps are necessary to put the system back into operation.

Each part of the system must be carefully inspected. No attempt should be made to straighten kinked tubes or repair any bent or broken units. Check especially for cracks at soldered connections.

REFRIGERATION SYSTEM OPEN TO ATMOSPHERE

Broken tubes or units will allow air, moisture and dirt to enter. These parts should be sealed as soon as possible until such time as they are replaced.

If the system is open for more than 15 or 20 minutes (depending on humidity), the receiver-dehydrator assembly will absorb an excessive amount of moisture and should be replaced, and each component of the system should be cleaned with dry nitrogen and flushed with liquid refrigerant to remove dirt and moisture.

FLUSHING SYSTEM

Flushing can be accomplished by connecting a refrigerant drum to the unit to be flushed and then turning the drum upside down and opening the drum shut-off valve to force refrigerant through the unit. The unit should be supported so that the refrigerant passing through it will be directed into an area where -21.7°F., will do no damage.

CAUTION: Remember that when liquid refrigerant is released from the drum into an area where atmospheric pressure exists, its temperature will immediately drop to -21.7°F.

In order to keep the expansion valve open when flushing the evaporator, the expansion valve bulb must be detached from the evaporator outlet tube.

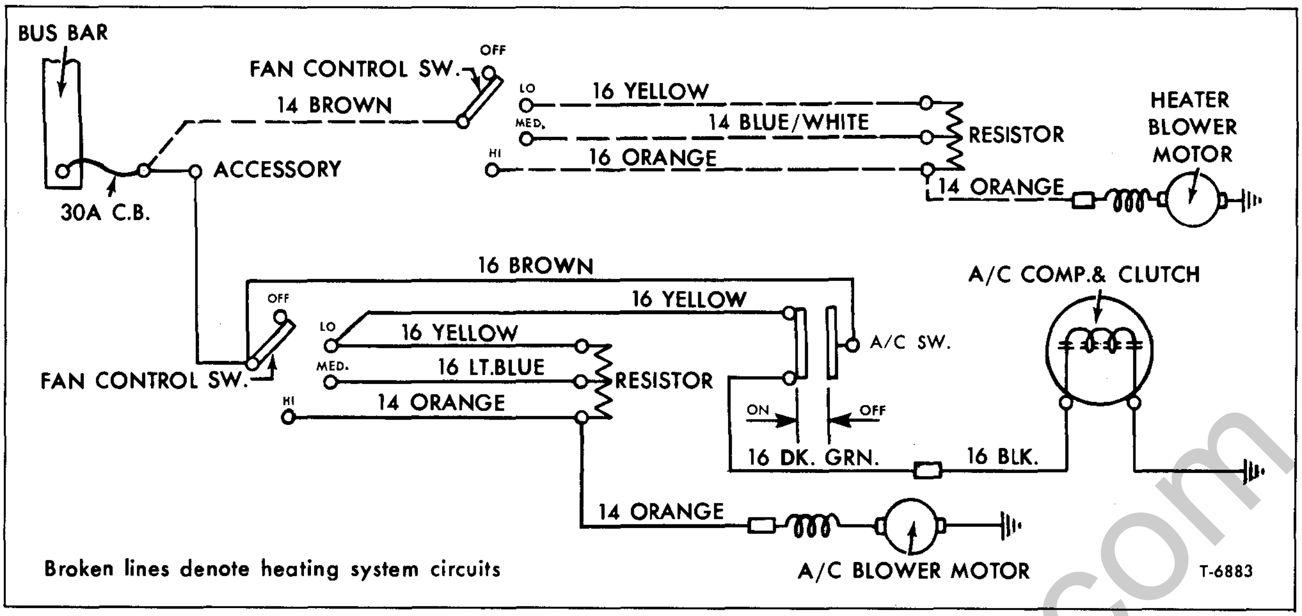


Figure 33—Air Conditioning and Heater Wiring

INSPECTING COMPRESSOR

If there is no visible evidence of damage, rotate compressor shaft to test for normal reaction. A quick check for broken reed valves is to turn compressor shaft (using box end wrench on compressor shaft nut) and check for resistance when turning the shaft. An irregular resistance force will be felt as each of the pistons goes over top center for each revolution of the crankshaft. If this pattern is not felt, it indicates one or more broken compressor red valves and the compressor must be repaired.

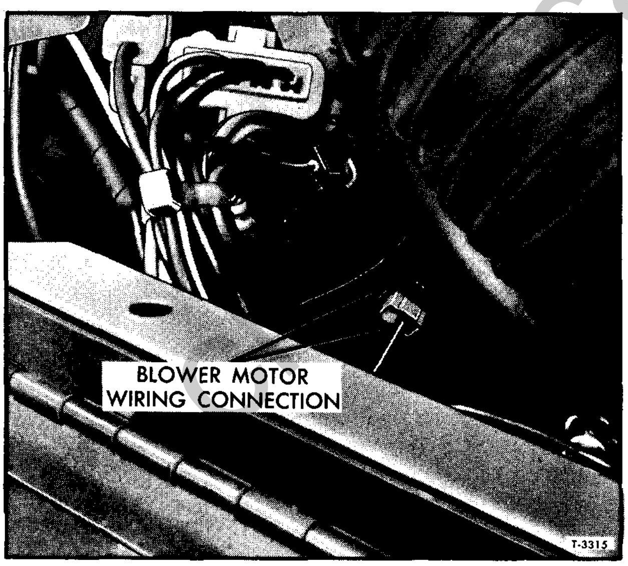


Figure 34—Blower Motor Wiring Connection

Inspect oil for foreign material which would indicate internal damage to the compressor. If no foreign matter is found in oil, compressor can be used. Flush entire refrigeration system with refrigerant, drain oil from compressor and pour in 11 oz. of new Frigidaire 525 viscosity oil.

BLOWER MOTOR REPLACEMENT (ALUMINUM TILT CAB)

The dual blower motors, which are electrically connected in paralle, are fed from a four-position control switch and resistor network. All blower electrical circuits are protected by an automatic reset circuit breaker. Refer to master wiring diagram on center console access cover when trouble-shooting heater electrical circuits.

IMPORTANT: Before attempting to remove any electrical component, be sure to pull out reset button on master circuit breaker to allow service to heater wiring without danger of shorting out. A white ring around base of button is visible when master circuit breaker is open.

1. Pull reset screw button on master circuit breaker or disconnect battery ground cable.

2. Remove passengers seat and platform. Refer to "Cab and Sleeper Compartment" in "ALUMINUM TILT CABS" (SEC. 1D) of this manual for seat replacement procedures.

3. Disconnect electrical leads from blower motors.

4. Tilt cab slightly and remove bolts (from beneath cab floor) which retain blower motor assembly to cab floor.

> **CAUTION: Be sure to insert lock pin into serrated channel assembly before working beneath cab. This is a safety precaution.**

5. Lower cab. From inside cab remove remaining bolts retaining blower motor assembly to cab floor.

6. Carefully tilt blower housing assembly and remove from cab.

NOTE: Be careful not to tear elastic couplings positioned on air ducts between blower housing and main heater housing.

To install blower motors, reverse removal procedures.

BLOWER MOTOR REPLACEMENT (CONVENTIONAL CAB)

NOTE: Refer to figure 33 for wiring diagram.

1. Disconnect motor ground wire from dash panel flange.
2. Pull motor switch lead at quick-disconnect terminal (fig. 34).
3. For access to blower mounting screws, pull back the cellular insulating material at motor hose plate. Remove screws, then pull motor assembly from shroud. Rotate hose plate so that cut-off is at the top before removing.
4. Install the motor unit by reversing the previous procedures.

NOTE: After installing attaching screws, seal down the insulating material using a light coat of rubber cement.

NOTES ON STORING AND INSTALLING A/C COMPONENTS

1. All sub-assemblies are purged and sealed before shipment. Shipping caps should not be removed until just prior to making connections.
2. All sub-assemblies should be at room temperature before uncapping to prevent condensation of moisture.
3. A complete or partially built-up system should not remain uncapped longer than necessary to make a connection.
4. Precautions should be taken to prevent damage to fittings or connections.
5. Use only a cloth dipped in alcohol to remove grease or dirt from the outside of fittings.
6. Components of questionable condition should not be used.
7. If dirt, grease, or moisture gets inside the lines, the lines should be replaced or flushed.
8. If internal cleaning of components is required, only dry nitrogen or Refrigerant-12 can be used.
9. Prior to assembly, use a small amount of fresh refrigerant oil on all tube and hose joints and on O-rings.
10. When tightening joints, use a second wrench to hold the stationary part of the stationary part of the connection to prevent twisting and hose kinking.
11. Tighten all connections in accordance with recommended torques.
12. To ensure maximum moisture protection, do not connect the receiver-dehydrator until all other assemblies have been connected.

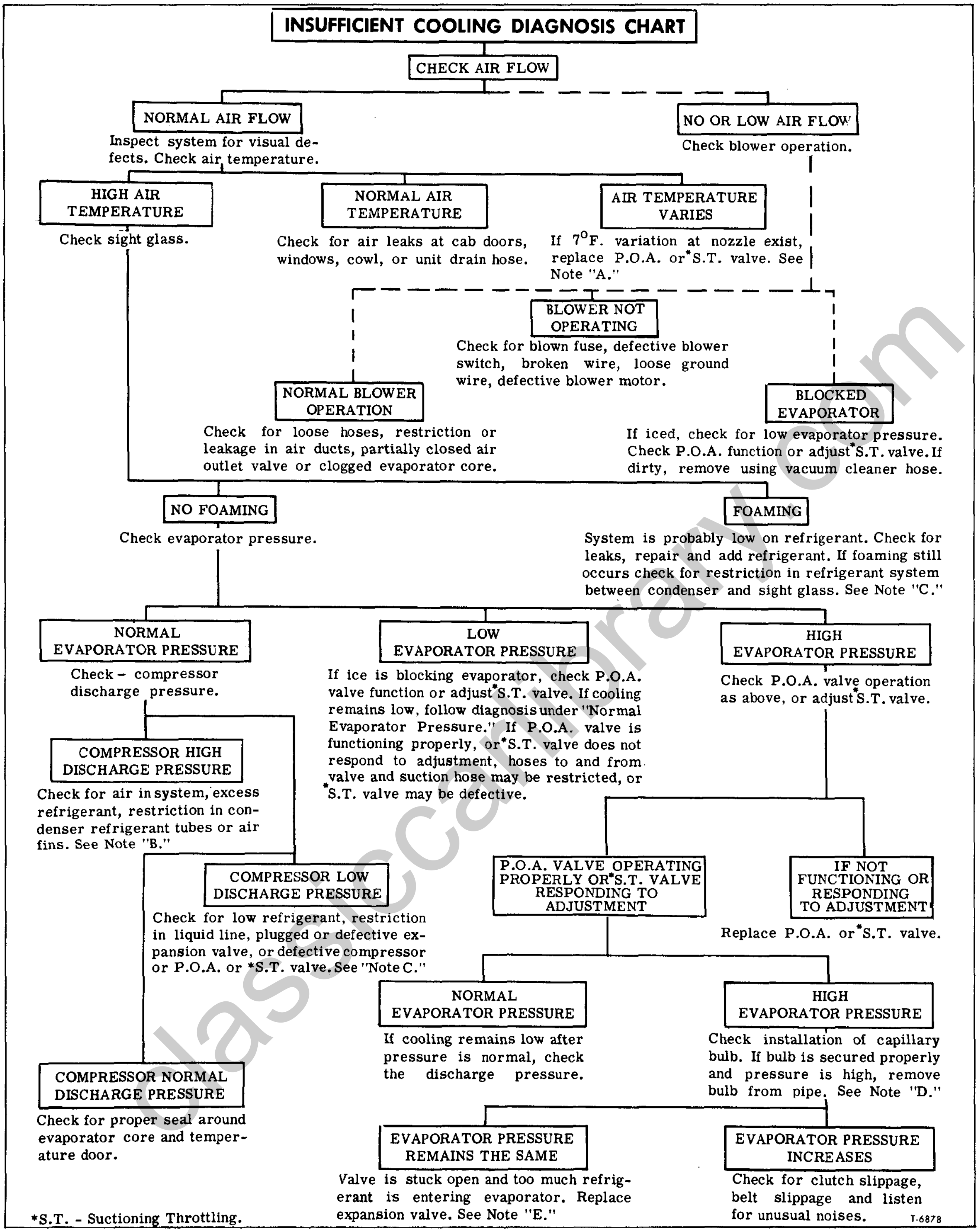


Figure 35—Diagnosis Chart for Air Conditioning

INSUFFICIENT COOLING DIAGNOSIS CHART

(Used in Conjunction With Chart on Opposite Page)

NOTE "A"

P.O.A. or suction throttling valve piston sticking; if stuck closed, no cooling due to lack of flow of refrigerant through the evaporator core; if stuck open, no controlled cooling and cab may get too cold - evaporator may freeze. Replace valve.

NOTE "B"

System with excess discharge pressure should be slowly depressurized at the receiver-dehydrator inlet connection, observing the behavior of the high pressure gauge indicator.

1. If discharge pressure drops rapidly, it indicates air (with the possibility of moisture) in the system. When pressure drop levels but still indicates in excess of specifications shown in the "Operational Test Data Chart," slowly bleed system until bubbles appear in the sight glass and stop. Add refrigerant until bubbles clear, then add one (1) pound of refrigerant. Recheck operational pressures. If discharge pressure still remains above specifications and the suction pressure is slightly above normal, then a restriction exists in the high pressure side of the system.

2. If discharge pressure drops slowly, it indicates excessive refrigerant. If pressure drops to specifications and sight glass remains clear, stop depressurizing and recheck operational pressures. If pressures are satisfactory, depressurize until bubbles appear in the sight glass, stop depressurizing, then add one (1) pound of refrigerant. Recheck operational pressures.

3. If discharge pressure remains high after depressurizing the system, continue depressurizing until bubbles appear in the sight glass. If suction pressures also remain high, then the P.O.A. or suction throttling valve may require replacement or adjustment, as well as a restriction in the high pressure side of the refrigeration system. The system will have high pressure control more frequently under this condition.

Install gauge set and bleed off refrigerant from compressor suction and discharge side for 20 seconds. After 20 seconds close valves and recheck operating pressures. Repeat until discharge pressure is normal. Check sight glass; if bubbles appear it indicates that air was in system. Charge with refrigerant as follows: 2000 engine rpm, "OUTSIDE" air, "HI" blower and maximum cooling. Add refrigerant until sight glass clears, then add one (1) pound additional.

NOTE "C"

Check for presence of bubbles or foam. If bubbles or foam is noted, charge with refrigerant as follows: 2000 engine rpm, "OUTSIDE" air, "HI" blower and maximum cooling. Add refrigerant until sight glass clears, then add an additional one (1) pound.

NOTE: It is not unusual for bubbling to occur on minimum cooling and "LO" blower in mild weather even with a fully charged system.

NOTE "D"

Remove insulation and inspect for clearance between tube and bulb. If gap exists, move bulb to establish contact, reclamp and reinsulate.

NOTE "E"

Remove expansion valve and inspect internal screen for foreign objects. If present, there is a possibility seat is being held open. Install new expansion valve; if condition is corrected, discard the valve removed.

NOTE: Specifications are found on the following page.

T-6879

Figure 36—Diagnosis Chart Notes

REFRIGERANT LINE CONNECTIONS TORQUE SPECIFICATIONS

OUTSIDE DIAMETER OF METAL TUBING	TORQUE FT.-LBS. (STEEL)	TORQUE FT.-LBS. ALUMINUM OR COPPER
1/4	10 - 15	5 - 7
3/8	30 - 35	11 - 13
1/2	30 - 35	15 - 20
5/8	30 - 35	21 - 27
3/4	30 - 35	28 - 33

NOTE: Steel torques to be used only when tube is mated steel-to-steel. If steel connection is made to aluminum or copper tube fittings, use appropriate "ALUMINUM OR COPPER" torque specifications.

AIR CONDITIONING SPECIFICATIONS

Compressor
- Type....6 Cylinder Axial
- Displacement....12.6 cu. in.
- Rotation....Clockwise

Compressor Clutch Coil
- Ohms (at 80°)....3.85
- Amps. (at 80°)....3.2 @ 12V

System Capacities:
- Refrigerant (Aluminum Tilt Cab)....4 lb. 8 oz.
- Refrigerant (Conventional Cab)....3 lb. 4 oz.
- 525 Viscosity Refrigerant Oil (Entire System)....11 fluid oz.

Compressor Drive Belt Tension* (V-Belt)
- New....120-130 lbs.
- Used....80-90 lbs.

Compressor Drive Belt Tension** (Poly V-Belt)
- New....84-94 lbs.
- Used....64-74 lbs.

Evacuation Period (@26 to 28 in. of vacuum)....15 to 30 min.

*Using J-23573 Belt Tension Gauge.
**Using J-23586 Belt Tension Gauge.

Do not use lighted Leak Detector (J-6084) in any area where combustible vapors may be present. Although the torch flame is small and well protected, it is recommended that a fire extinguisher be placed near-by for any emergency that may arise.

SECTION 2

FRAME

GENERAL

This section includes general instructions for checking frame alignment and recommendations for frame repair and reinforcement. It must be pointed out that the information is provided to assist in the repair or reinforcement of frames, using the most desirable practices. This section was prepared to aid competent personnel in the repair or reinforcement of frames.

Channel-type frame (fig. 1) construction with riveted crossmembers is used on all models. Frame side rails are usually of S.A.E. 1023 steel. On some vehicles, special heat-treated or S.A.E. 950 hi-tensile steel side rails may be used.

In the event the vehicle is damaged in a collision, carefully check for proper frame alignment in addition to steering geometry and axle alignment.

FRAME ALIGNMENT CHECK

The most convenient way to check frame alignment, particularly when the cab or body is on the chassis, is to select various corresponding points of measurement on the outside of each side rail and then, by use of a plumb bob, transfer these points to a layout on a level floor. (NOTE: Flange width may vary ± 3/16".) The selection of these points is an arbitrary matter; however, it is an important factor to remember that for each point selected on the left side rail, a corresponding point must be used on the right rail. The illustration (fig. 1) is used merely to serve as a guide in the selection of checking points "M."

In order to obtain reliable results, checking must be done thoroughly and accurately. After all corresponding points have been carefully transferred from the vehicle frame to the floor layout, move the vehicle away from the layout and proceed as directed in the following steps:

NOTE: Key letters in the following text refer to figure 1.

1. Check the frame width at front and rear ends using the corresponding marks on the floor. If widths correspond to specifications (refer to "Specifications"), draw centerline full length of vehicle layout bisecting points indicating front width (WF) and rear width (WR). If frame widths are not correct, layout centerline as directed in Step 4.
2. With centerline properly laid out, measure the distance perpendicular from the centerline to corresponding points on each side over the entire length of the chassis. If the frame is in proper alignment, measurement should not vary more than an 1/8" at any corresponding point.
3. Where improper alignment is encountered, the point at which the frame is sprung may be located by measuring pairs of corresponding diagonals marked "A" or "B." If the length of each pair of diagonals ("A" or "B") are within 1/8" and the intersection point of the diagonal pairs is within 1/8" of the centerline, the portion of the frame

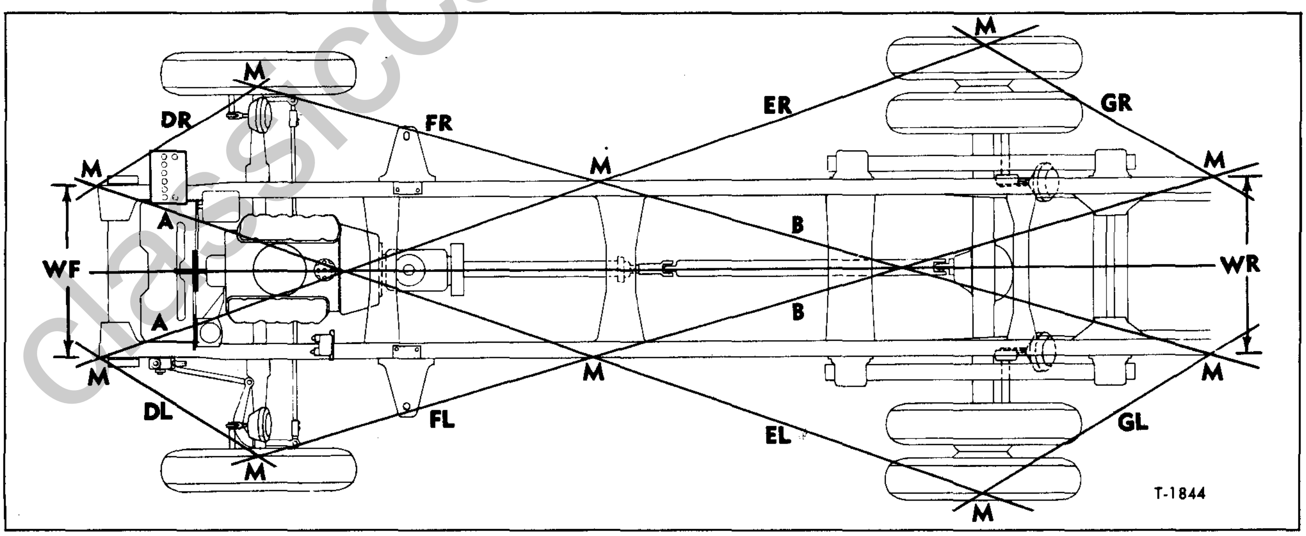


Figure 1—Typical Frame Alignment Points

included between the points of measurement may be considered to be in proper alignment. Variation of more than a 1/8" indicates misalignment.

4. If the frame centerline cannot be determined by method indicated in Step 1, the centerline may be established by drawing a line through the intersection points of equal pairs of diagonals or from the intersection of equal diagonals through the midpoint of either correctly established front or rear frame widths. This method is usually required when front or rear end damage is incurred as the result of a collision.

5. After it has been determined that the frame is properly aligned, axle alignment with respect to the frame can be checked as directed below: (See fig. 1.)

a. Front axle alignment with respect to the frame is correct if "FR" equals "FL" and "DR" equals "DL." This can be concluded if both front and rear frame ends have been established as properly aligned (Step 3).

b. Rear axle alignment with respect to the frame is correct if "ER" equals "EL" and "GR" equals "GL." NOTE: Alignment may appear to be off if rear ends of frame rails are not cut-off evenly when reducing cab to end of frame (CE) for specific operations.

Straightening Frames

The practice of straightening frames should not be attempted by inexperienced personnel, as more damage can result from improper methods. Internal stresses can be introduced into the material by improper frame straightening. For this reason the following restrictions should be adhered to completely:

1. Frame straightening should be attempted only by experienced personnel.

2. Heat may be applied to S.A.E. 950, or S.A.E. 1023 steel only by competent personnel. The material temperature should not exceed 1200° (dull red glow). It must be strongly pointed out that excessive heat will damage the material structure characteristics of the frame rail.

3. Frame members which are bent or buckled sufficiently to show strains or cracks after straightening should be replaced.

IDENTIFICATION OF MATERIAL

The importance of properly identifying the base rail before attempting to straighten or repair cannot be overemphasized. The results of incorrect welding or straightening methods may cause more damage to the frame than was originally experienced. For all practical purposes the S.A.E. 1023 and S.A.E. 950 material may be treated in the same manner.

The standard models as quoted in the GMC Data Book describe the physical dimension of the frame rail and specify the type of material used. However, due to the number of RPO's and Special Quotations available on most models, the Data Book inspection is not always a valid identification.

The material can be identified by the type of cut-out in the frame side rail at the front axle center line. See page 177 for cut-out identification.

Any reinforcements added must be of the same or better material than the base frame rail. This would permit the use of S.A.E. 950 reinforcements on S.A.E. 1023 base rails.

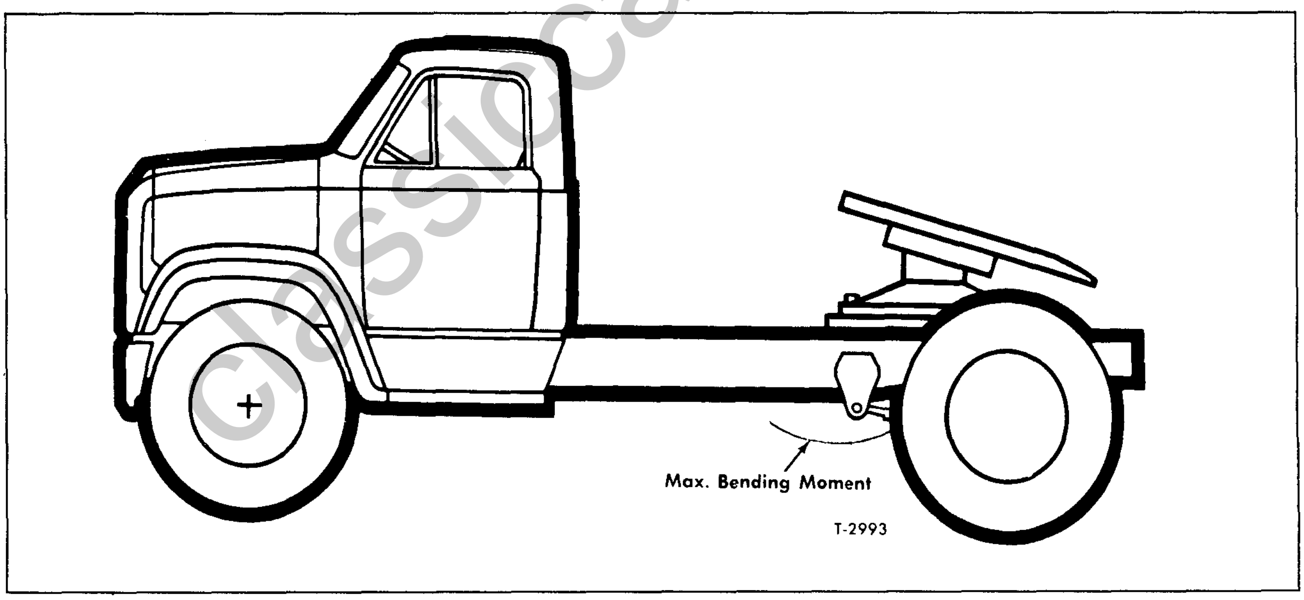


Figure 2—Frame Bending Moment (Typical Tractor)

The manufacturers and trade name of SAE 950 Hi-tensile steel are listed at end of this section to assist in the procurement of proper materials.

Also, listed under "Specifications" are the recommended welding electrodes to be used when repairing side rails.

ANALYZING FAILURE CAUSES

This analysis is not intended to cover the causes of all possible frame problems; however, it should be of valuable assistance in preparing complete, concise reports.

The purpose of this discussion is to emphasize the fact that frame failure don't just happen, there must be a cause or reason. An example of this would be a vehicle involved in a collision. The reason for failure in this case is apparent; however, other failures can be encountered where the reasons are not so apparent.

Frame failures can be classified by three types:
(1) Collisions
(2) Excessive bending moment
(3) Localized stress concentration

Failures caused by collision should be repaired, using proper methods and reinforcements, where necessary.

Excessive bending moment failures are caused by overload, improper weight distribution, or misapplication of the vehicle. Excessive bending moment failure will occur at different areas on various types of vehicles; therefore, for easier understanding, the effects of excessive bending moments will be discussed by type of vehicle.

TRACTORS

The maximum bending moment of vehicles used in tractor service is in the area of the leading edge of fifth wheel (fig. 2). Failures may be caused by overload, excessive fifth wheel setting, excessive fifth wheel heights, poor fifth wheel installations, severe operating conditions and severe braking operations (inertia of certain loads), which induce excessive bending moments in the frame. These failures will start at edge of lower flanges and progress across the frame flange and up the web section of the frame rail. Instances may occur where upper or lower frame flanges buckle.

STRAIGHT TRUCKS

The maximum bending moment occurs in the area near the rear of the cab on vehicles having van or platform bodies (fig. 3). Failures may be caused by overload or can occur when loads are dispersed in diminishing quantities allowing the balance of a load to remain in the extreme front of the body.

In both tractor and straight truck operation the highest tensile stress is applied to the bottom side of the lower frame flange. However, it must

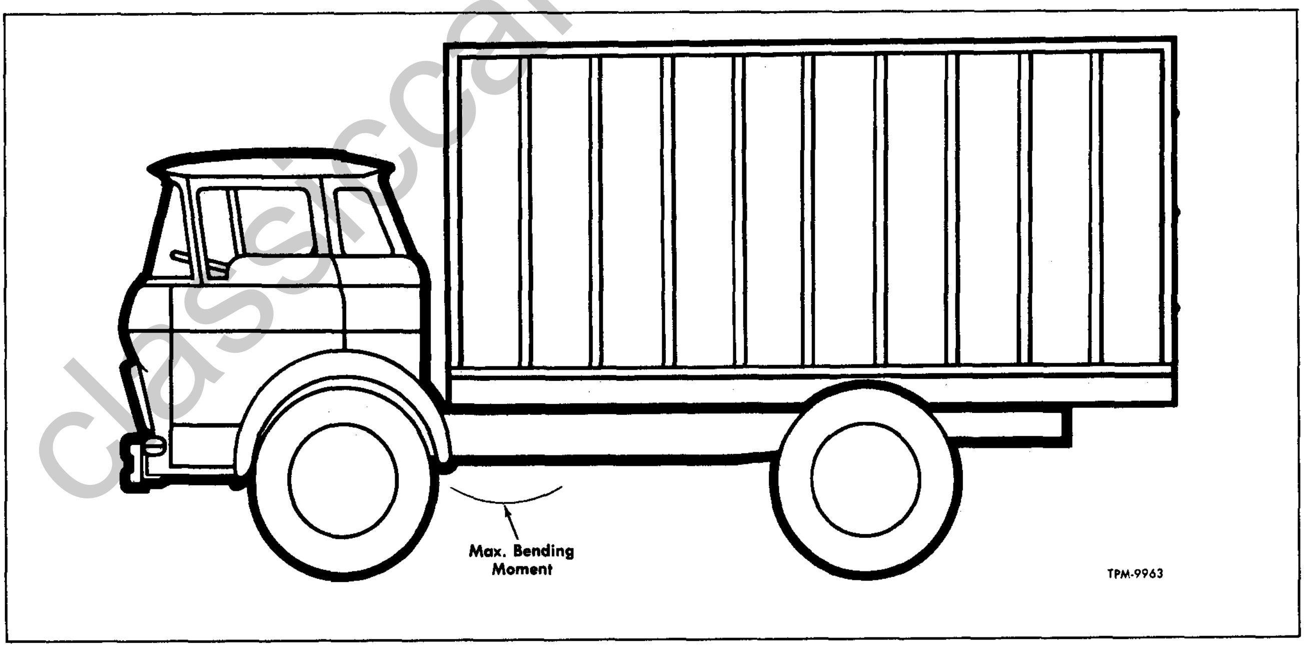


Figure 3—Frame Bending Moment (Typical Straight Truck)

be pointed out that dump trucks, as an example, when operated with the box in a raised position causes the center of gravity of the load to move behind the rear axle centerline resulting in a change of maximum tensile stress location from the bottom of the lower flanges to the top of the upper flanges (fig. 4). This information can be very useful when examining cracks on vehicles used in dump service, as it would appear that the vehicle has been operated at excessive speed over rough terrain while spreading with the dump box in the raised position or with too long a dump box for wheelbase selected.

Localized stress concentration failures may be the result of bending moment stresses; however, it must be pointed out that the stress levels would not be high enough to cause any difficulty without localized stress concentration points. These localized stress concentration points may be caused by poor body or fifth wheel mountings, special equipment or accessory installation, improper welding or welding methods, improper reinforcements, loose bolts or rivets and defective material. They may also occur as a result of high bending loads, coupled with severe torsional loads as may be found in off-road service.

The proper installation of fifth wheels or bodies is covered in the "Body Builder's Book"; however, it should be re-emphasized that the use of U-bolts for attachment of fifth wheels or bodies is not an approved installation as high stress concentration may develop. The desired fifth wheel or body mounting is attached to the frame rail web section, not through flanges. Heat-treated rails must not have attachments welded to the frame. Wood sills should be used between main rails and sub-frame on body installations to insure good load distribution.

Special equipment or accessory installation can cause high stress concentrations due to the method of attachment or the weight of the equipment. Holes should never be drilled through the flanges and rapid changes of section modulus should be avoided. These section modulus changes usually occur when large mounting plates are added for supporting special equipment. Heavy equipment mounted across the flanges or on the web of a side rail may cause enough stress concentration to cause failures at the nearest crossmember, bracket, or other frame stiffener or through a nearby hole in the frame flange.

IMPORTANT

Improper welding or welding methods are a major cause of stress concentration points, which may ultimately result in frame failure. (Refer to "General Welding Instructions.")

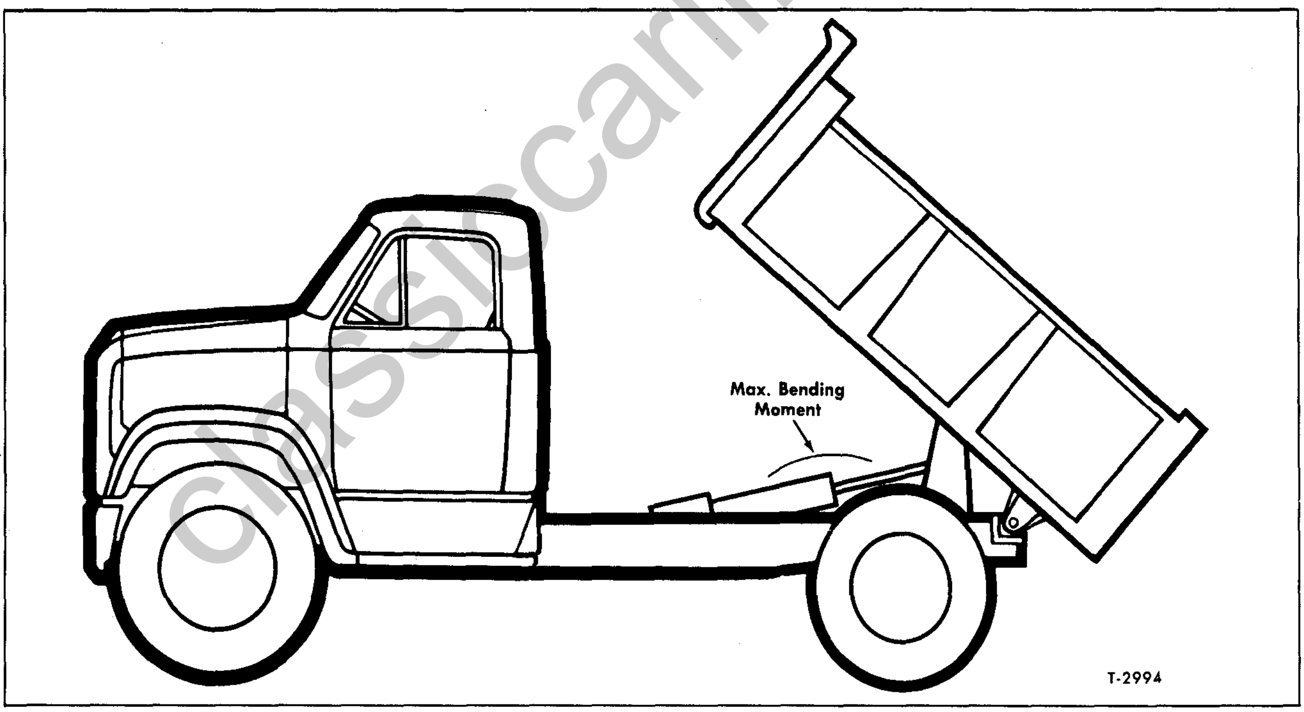


Figure 4—Frame Bending Moment (Typical Dump Truck)

Improper reinforcement or attachment of reinforcement may cause more difficulty than the original problem as the creation of localized stress concentrations may reduce the frame load carrying capacity below the original frame before adding reinforcements. The use of rivets for attaching reinforcement during field modification is generally not recommended due to the lack of proper riveting equipment in most service locations. For this reason it is recommended that most reinforcements be attached with 300-M bolts and that hardened washers be placed on both ends of the bolt to provide a good torquing surface and to maintain tight bolts.

GENERAL WELDING INSTRUCTIONS

Good welding is a very favorable method of attachment or repair; however, improper welding or welding procedure may result in further frame damage. Additives of reinforcements may be necessary in the repair area to prevent reoccurrence.

WARNING: Before welding, disconnect one or both battery cables.

WELDING EQUIPMENT

CAUTION

NEVER USE OXYACETYLENE FOR WELDING FRAME RAILS!!

There are several types of welding machines that are used for welding on frame rails. Listed below are the three most commonly used machines and their advantages:

1. DC (Rectifier Type) - This machine requires very little service as there are no moving parts, also reduces chance of arc blows.
2. DC (Motor-Generator Type) - The principle advantage is the power supply may be self-contained; thereby, this machine is readily portable and has very good voltage variation control and versatility with all types of electrodes.
3. AC - This is the least expensive and reduces possibility of arc blows; however, some difficulty may be encountered in striking an arc when using small diameter electrodes.

It is recommended that for all-purpose welding, the minimum capacity of any machine should be 350 amperes. There are four basic types of welding used in the repair or reinforcing of frame rails. All of these can be used with any type of material except heat-treated material which requires electrodes E12016 or E11018. Following are the descriptions of the types of welds;

a. Continuous Fillet Weld - This is used to weld a continuous bead along a reinforcement placed on the web section of the frame rail or for adding gussets or plates to crossmembers. Continuous fillet welds should never be made across frame flanges or along inside edges of frame flanges. When welding in the flat position use high range of electrode current and voltage chart. When welding overhead or in difficult areas, use low range of the electrode chart.

b. Groove Welding - This is a basic repair weld which is applied after the surface has been vee ground for good penetration. Particular care should be taken when welding cracks which cross either the upper or lower flanges. Weld completely then grind off the excess weld to eliminate the possibility of notches or weld build-ups on the flange edge. Use medium range of electrode chart.

c. Plug Welding - This is a good method of attaching reinforcements as it eliminates the possibility of loose fitting bolts; however, care must be exercised in locating plug welds in different types of reinforcements. E-6011 electrode is highly recommended for plug welding because of its good penetration and light coating. Use high range of electrode chart for flat or vertical plug welds. Overhead plug welding is very difficult and should not be used unless other approaches are not practical, then use high range for first pass and complete plug at medium range. Refer to plug weld table for size of hole to use for variations of material thickness.

d. Stitch (Intermittant Fillet) Welding - This type is not generally used on frames as continuous fillet welding provides better attachment; however, where warpage and heat control is critical, use stitch welding at medium range of electrode chart.

Other recommendations for all types of welding include:

1. Connect welding machine ground cables as close to working area as possible.
2. Where possible, use smaller diameter electrode and make several passes rather than large diameter electrode and single pass.

FRAME RAIL REPAIR

It is very important that repairs be correctly applied, as inadequate repairs will create additional localized stress concentration which may result in repeat failures. There are two basic types of cracks which may be encountered in frame difficulties (fig. 5). The straight crack or the multiple sunburst cracks which will radiate from a hole in the web section.

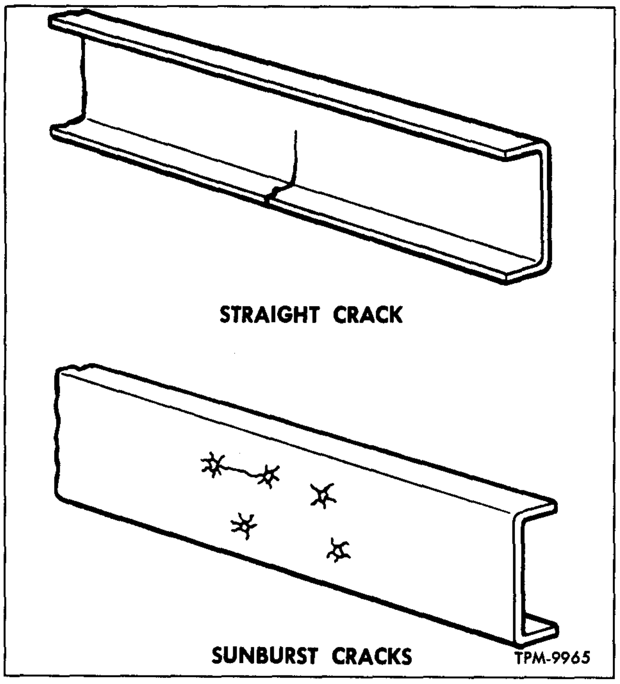


Figure 5—Types of Cracks

The straight crack will normally start from the edge of a flange and progress across the flange and then travel through the web section toward the opposite flange of the same rail. This may be caused either by localized stress concentration, excessive bending moment, or torsional loading. The sunburst type cracks are caused by high loads applied locally at the mounting bracket or crossmember whose attachment is not sufficiently adequate or is not securely fastened to the side rail.

In either case both types of cracks may be repaired using similar methods. The procedure for repairing frame rail cracks is as follows:

1. Remove any equipment that will interfere with workable access to the failure.
2. Locate the extreme end of the crack and drill a quarter inch hole. (NOTE: It may be necessary to align the frame and level the rails before repairing the frame.)
3. Vee grind the entire length of the crack from the starting point to the quarter inch hole at the extreme end. Using a hack-saw blade, the crack should be opened (1/16") to allow complete penetration of the weld.
4. Weld with proper electrode corresponding to the material of the basic rail.
5. Grind the weld smooth on both inside and outside of rail or reinforcement, being extremely careful to eliminate weld build-up or notches on the flange edges. (NOTE: Care should be taken when grinding not to reduce thickness of base rail.)
6. Quality and neatness of workmanship cannot be overemphasized. After the repair is completed, the repaired area should be painted and should not be readily discernible from the unrepaired area of side rail. Use a copper spacer between the flanges of cracked base rail flanges and reinforcement flanges and repair each flange separately as the flanges must react independently to prevent localized stress concentration.

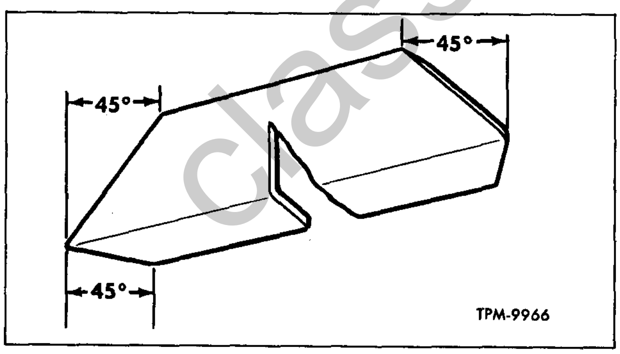


Figure 6—Scarfed (Tapered) Ends of Reinforcement

Buckled frame flanges should be straightened using proper alignment procedures, then an adequate reinforcement should be used (see frame reinforcement) or offending equipment remounted to obtain an improved transition of loaded to non-loaded areas. DO NOT WELD HEAT-TREATED RAILS EXCEPT TO REPAIR A CRACK.

Crossmember and Brackets

The repair of crossmembers may be accomplished if the damage is not extensive. Crossmember mounting flange cracks may be repaired in the same manner as side rail cracks; however, the weld bead should be built up to provide a good smooth radius. If extensive damage is incurred to a crossmember, the crossmember should be replaced, using bolts rather than rivets. All cast mounting brackets that are damaged should be replaced as it is not practical to weld a cast bracket. In the event that a frame crack appears in the area of cast bracket, the bracket must be removed while repair is made. Under no circumstances should a cast bracket be welded to the frame side rail.

REINFORCEMENTS

Review the discussion on analyzing causes of failures before applying reinforcement. A common misconception in the past was to patch a cracked frame. This is incorrect; reinforce the failed area. A reinforcement must be large enough (approx. 30 inches) to provide adequate stress relief from rapid changes in section modulus. For this reason it is extremely important that all reinforcement ends be scarfed to change section modulus as grad-

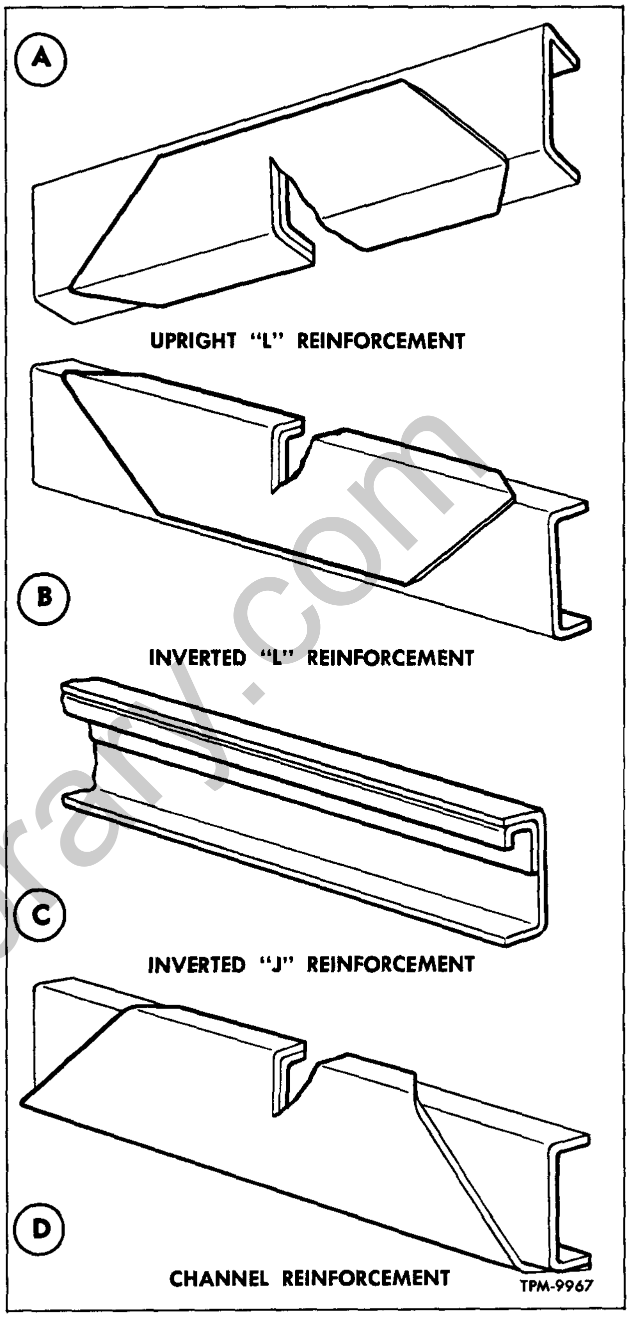


Figure 7—Frame Reinforcements

ually as possible with the longest section installed (fig. 6) in the area of highest loads.

There are five basic types of reinforcements that may be used on truck frames. However, it must be pointed out that the material used for the reinforcement must be similar to that of the base rail. Base rails of S.A.E. 1023 or 950 could use reinforcements of S.A.E. 950 material. S.A.E. 1023 rails may be reinforced with S.A.E. 1023 steel, but under no circumstances should strength of reinforcement be less than base rail. Figures 7 and 8 illustrate the five basic reinforcements.

1. Upright "L" Reinforcement - May be placed on either the inside or outside of the frame side rail. It should be used where maximum stress occurs at the bottom of the lower flange and buckling of the upper flange is not a problem. This reinforcement is quite versatile as it may be used in full length or in a short localized reinforcement. The configuration of the frame or spring hanger brackets may limit the use of the upright "L" reinforcement.

2. Inverted "L" Reinforcement - This may be used on the inside or outside of the frame rail. It is recommended where the maximum stress area is transferred to the upper flange; for example, dump trucks with the box in the raised position. This is also readily adapted where frame and hanger bracket design restricts using an upright "L" reinforcement or where frame upper flange buckling has been noted.

3. Channel Reinforcement - This may also be installed on the inside or outside of the frame side rail and can be full length or a localized reinforcement. The principle disadvantage of the channel is additional weight and hours of labor required to make an installation. Additional difficulty may arise when attempting to place the channel inside or over the existing rail due to manufacturing tolerances, cross members or mounting brackets.

4. Strap Reinforcements - This type of reinforcement may also be used to increase the section modulus of a frame if previous damage and repair has resulted in a loss of frame strength which would require additional modulus to return the frame strength to original design. These reinforcements are plug welded at 6 to 8 inch intervals. Do not weld across the end or along the flange edges. Ends should be cut at an angle and edges of plug welds must not be closer than 3/4" to the edge of a frame flange.

5. Inverted "J" Reinforcement - This is a rather new type of frame reinforcement that is designed to increase the flange strength to prevent flange buckling due to high torsional inputs or shock loading during tractor hook-up operations. The inverted "J" reinforcement is attached to the web section only with a spaced bolt pattern. This reinforcement has been released in six-foot lengths through the Factory Warehouse under GMC Part Number 2446489.

The attachment of reinforcement to the basic rail may vary somewhat with materials. The following general rules apply:

1. Do not use rivets. Proper riveting equipment is not generally available in most field service outlets; therefore, the use of 300M bolts and hardened flat washers are recommended.

2. Reinforcements, with the exception of strap

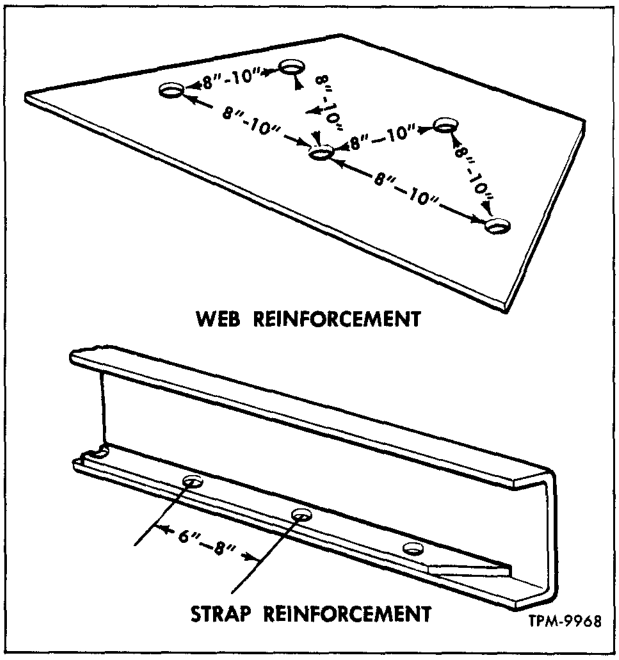


Figure 8—Plug Patterns of Strap Reinforcements

type, should not be attached to the flanges except in the case where a mounting bracket or crossmember holes are already through the frame flange.

3. Plug welds may be used in a staggered 8 to 10 inch pattern when attaching reinforcements to the web section (fig. 8).

4. Strap reinforcements may be plug welded at 6 to 8 inch intervals to the flanges in some cases; however, as pointed out, this is for section modulus increase and should only be attempted by highly qualified specialists.

The termination of reinforcements is very important. Reinforcement ends must be scarfed or stress relieved to prevent localized stress concentration. This scarfing should not be greater than 45° (fig. 6). It should also be strongly emphasized that in cases where several reinforcements are used, the ends of the reinforcements must overlap and be staggered so that the reinforcement ends overlap by eight to ten inches.

— CAUTION —
GENERAL RULES

Listed below are general rules which apply to frame repair and reinforcements. Most of these rules are discussed earlier in this section; however, the importance of adhering to them cannot be overemphasized.

1. Always identify the material of base rail.
2. Frame straightening or repair must be attempted only by highly qualified specialists.
3. Always attempt to identify the cause of failure.
4. Fifth wheel, body, and accessory mountings should not be made through frame flanges. (See "Body Builder's Book".)
5. Do not drill holes in the lower flanges.
6. Use only proper electrodes as specified for base rail material when welding is necessary.
7. Do not use oxyacetylene welding equipment on frames.
8. Do not weld reinforcements across the frame flanges.
9. Do not weld within 3/4 inch of the edge of a frame flange.
10. Remove all notches or weld build-ups from flange edge when repairing a broken frame.
11. Do not weld cast brackets to frame.
12. Do not weld the flanges of cracked reinforcements and base rails together.
13. Do not patch cracks. Reinforce the area.
14. Reinforcement should be of the same or better material than base rail.
15. Always scarf reinforcement ends to provide adequate stress relief.
16. Always stagger ends of reinforcements by a minimum of eight inches apart.
17. The Zone Office or Factory should be contacted when repairs are necessary on heat-treated side rails.

FRAME SPECIFICATIONS

ELECTRODE CHARTS

E-7011

Available Sizes	Flat Welding Current Range	Flat Welding Arc Voltage
3/32" X 12"	45— 80	21—23
1/8" X 14"	80—115	21—23
5/32" X 14"	125—165	22—24
3/16" X 14"	160—200	22—24
7/32" X 18"	200—250	23—25
1/4" X 18"	250—320	23—25
5/16" X 18"	325—400	24—28

	Overhead Welding	
3/32" X 12"	45— 75	20—22
1/8" X 14"	80—110	20—22
5/32" X 14"	125—150	21—23
3/16" X 14"	150—175	21—23

E-7016

	Flat Welding	
5/64" X 9"	30— 60	20—22
3/32" X 12"	50— 80	20—22
1/8" X 14"	90—125	22—24
5/32" X 14"	120—190	22—24
3/16" X 14"	175—240	22—24

PLUG WELD CHART

Thickness of Material	Diameter of Plug	Depth of Plug
1/4	3/4	1/4
3/8	1	3/8
1/2	1 1/8	7/16
5/8	1 1/4	1/2
3/4	1 3/8	9/16
1	1 1/2	9/16

S.A.E. 950 HIGH STRENGTH LOW ALLOY STEEL

Trade Name	Type	Source
N-A-X	—	Great Lakes Steel
Jalten	#1	Jones & Laughlin Steel Company
Republic Double Strength	—	Republic Steel Company
Republic "50"	—	Republic Steel Company
Yoloy	"S"	Youngstown Steel & Tube Company
Man-Ten	—	U. S. Steel
Medium-Manganese	—	Bethlehem Steel Company
Tri-Ten	"E"	U. S. Steel

FRAME WIDTHS

Model	Front Width*	Rear Width*
"C", "M", "H" and "J"	34 1/8"	34 1/8"
TO	53 5/16"	34 1/16"

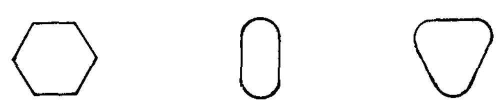
*Outside Dimension of Base Rails

ELECTRODE USAGE WITH FRAME MATERIAL

Material	1023-950	Heat-Treated
Type of Electrode	E-7011	E-12016
Alternate Electrode	E-7016	E-11018

Side Rail Material Identification
(Location—Centerline of Front Axle)

HEAT-TREATED SAE1023 SAE950



Frame repairs should be undertaken only by competent mechanics, and only the recommended materials should be used.

SECTION 3

FRONT SUSPENSION

This group is divided into four sections as shown in Index below:

NOTE: Illustrations are numbered consecutively within each section.

FRONT END ALIGNMENT

Proper alignment of front wheels must be maintained to ensure efficient steering and satisfactory tire life. The most important factors of front end alignment are wheel toe-in, wheel camber, and axle caster. Front end alignment should be checked at regular intervals, and particularly after front axle has been subjected to heavy impacts such as a collision or a hard curb bump. Before checking alignment, wheel bearings must be properly adjusted since loose wheel bearings will affect instrument readings when checking wheel toe-in, wheel camber, and axle caster. Steering components also must be in good condition and free of excessive wear.

When checking alignment, instructions outlined in this section should be followed carefully, as well as instructions covering related units such as brakes, springs, steering gear, hubs and bearings, and wheels and tires, which are given in other sections of this manual. Front End Alignment Chart (fig. 1) indicates points at which alignment dimensions are taken.

The caster, camber, and toe-in dimensions are for vehicle at design load (with frame level). If frame is not level on alignment equipment, the frame angle must be considered. This is especially important when making caster check for the frame angle must be added to the caster angle to obtain a true setting. All alignment checking should be done with precision equipment and instruments.

DEFINITION OF TERMS

WHEEL TOE-IN

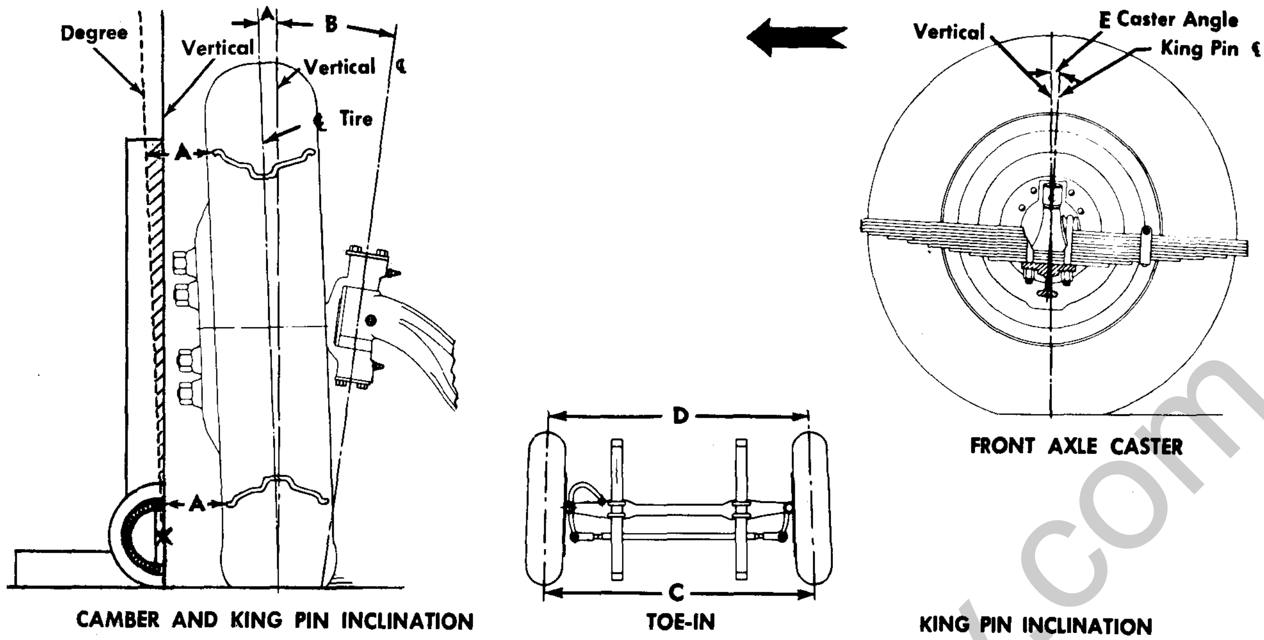
Distance front wheels are closer together at front than at rear of axle (see "C" and "D" fig. 1).

WHEEL CAMBER

Amount wheels are inclined from vertical plane (see "A," fig. 1).

SERVICE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
Noisy Front End	1. Loose tie rod ends.	1. Replace ends.
	2. Lack of proper lubrication.	2. Refer to LUBRICATION (SEC. 0).
	3. Broken spring leaf.	3. Replace spring leaf.
	4. Loose U-bolts or spring clips.	4. Tighten.
Wheel Bounce	1. Unbalanced wheels or tires.	1. Refer to balancing (SEC. 10).
	2. Unequal tire pressure.	2. See Load and Inflation Table (SEC. 10).
	3. Weak or broken front spring.	3. Replace.
	4. Excessive wheel or tire run-out.	4. Refer to WHEELS AND TIRES (SEC. 10).
Excessive tire wear	1. Incorrect wheel alignment.	1. Align wheels (SEC. 3A).
	2. Failure to rotate tires.	2. Refer to WHEELS AND TIRES (SEC. 10).
	3. Improper tire inflation.	3. Refer to Load and Inflation Table (SEC. 10).
	4. Overloaded or improperly loaded.	4. Avoid overloading vehicle.



*A .... Camber (Degrees Positive)

*B .... King Pin Inclination (Degrees)

*C MINUS D .... Toe-in (Inches)

*E .... Caster (Degrees Positive)

*Refer to "Specifications" for correct dimensions.

T-4438

Figure 1—Front End Alignment Chart

FRONT AXLE CASTER

Inclination of kingpin from the vertical in the fore and aft direction of the vehicle (see "E," fig. 1).

KING PIN INCLINATION

The slant of the kingpin toward the center of the vehicle at the top and outward at the bottom (see "B," fig. 1).

FRONT END INSPECTION

Before checking front end alignment, the following front end inspection should always be made:

1. Check tires for proper inflation.

NOTE: Rim-to-floor dimension should be the same at each wheel.

2. Check wheel installation and run-out.
3. Check wheel bearing adjustment.
4. Check steering tie rod and drag link ends for looseness.
5. Check kingpins for looseness.

CHECKING AND CORRECTING FRONT WHEEL TOE-IN

Incorrect toe-in results in excessive tire wear caused by side slippage and also unstable steering with a tendency to wander. Toe-in may be measured from center of tire treads or from inside of tires. Measurements are made at both front and rear of axle (see "C" and "D," fig. 1).

When setting "toe-in" adjustment, the front suspension must be neutralized; that is, all component parts must be in the same relative position when making the adjustment as they will be when in operation. To neutralize the suspension, the vehicle must be rolled forward 12 to 15 feet. By rolling the vehicle forward, all tolerances in the front suspension are taken up and the suspension is then in normal operating position. Neutralizing the front suspension is extremely important, especially if the vehicle has been jacked up in order to scribe the tires, otherwise the front wheels will not return to the normal operating position due to the tires gripping the floor surface when the vehicle is lowered on the jack.

IMPORTANT: "TOE-IN" MEASUREMENTS MUST BE MADE AT THE HORIZONTAL AXIS OF THE WHEEL.

"Toe-in" is corrected by loosening clamp bolt at tie rod ends, then turning tie rod with pipe wrench until wheels have proper toe-in.

NOTE: On vehicles with power steering, loosen power cylinder-to-tie rod bracket U-bolt nuts.

With both tie rod ends in same plane, tighten clamp bolts securely. Toe-in should be 1/8 to 1/4 inch except on FE-970 axle. See "Alignment Specifications."

With power steering, tighten power cylinder-to-tie rod bracket U-bolt nuts. Adjust power cylinder as directed in "POWER STEERING" (SEC. 9B) of this manual.

FRONT WHEEL CAMBER

Camber is the amount in inches or degrees that front wheels are tilted outward at top from vertical position (see "A," fig. 1). Camber offsets wheel deflection, due to wear of front axle parts, and prevents a reverse or negative camber condition. A reverse or negative camber is an inward inclination of wheels at the top.

If camber is extreme or unequal between wheels, improper steering and excessive tire wear will result.

Camber variations may be caused by wear at wheel bearings and steering knuckle bushings, or by a bent steering knuckle or axle center.

Specifications are listed at rear of this section.

NOTE: The Timken FE-970 axle as used on some vehicles is of the centerpoint steering type and has only a very slight camber dimension.

CHECKING AND CORRECTING CAMBER

Before checking camber, check wear at king pins as follows:

Jack up front of vehicle, pull bottom of wheel outward and take a camber reading; then pull top of wheel outward and take a camber reading. If readings vary more than $\frac{1}{4}^{\circ}$, make following adjustments:

1. Adjust the wheel bearings as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D), then take camber readings as shown on chart (fig. 1). If readings still vary over $\frac{1}{4}^{\circ}$, replace steering knuckle bushings and king pins as instructed in "FRONT AXLE" (SEC. 3B).

2. Check the wheel run-out as instructed in WHEELS AND TIRES (SEC. 10) of this manual. If run-out is excessive, straighten or replace wheel.

3. Place vehicle on level surface, with normal

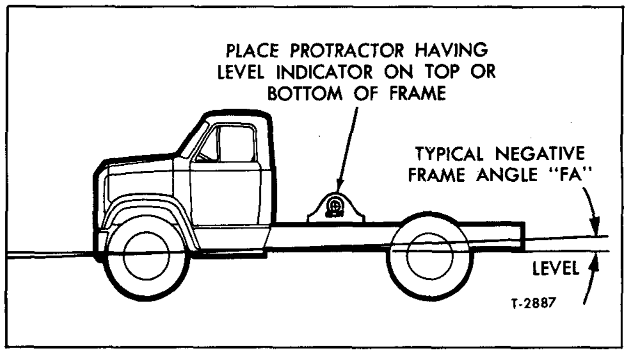


Figure 2—Method of Checking Frame Angle

weight of vehicle on wheels, then take final camber reading. If camber gauge is not available, readings can be taken as shown on chart in figure 1.

Camber may be checked using a large square and protractor, as follows:

Scribe a line from center point of protractor to top of square on correct degree of angle as determined from specifications at end of this section.

Place square on floor adjacent to center of wheel as shown in figure 1. Measure distance between scribed line on square and wheel rims at top and bottom. If readings taken are both identical, camber is correct. If readings differ, steering knuckle bushings are worn or axle center is bent. The knuckle also may be bent. Camber dimensions of right wheel should not vary over 3/32-inch from camber dimensions of left wheel.

4. To determine which part is bent, check king pin inclination (B, fig. 1). If king pin inclination is correct, then steering knuckle is bent. Method of checking king pin inclination without use of instruments is described under "King Pin Inclination" later in this section.

AXLE CASTER

Positive caster is the rearward tilt from the vertical of the king pin. Negative or reverse caster is the forward tilt from the vertical of the king pin.

Incorrect caster may result from sagging springs, bent axle, twisted axle, or uneven tightening of spring U-bolt nuts. Tighten all U-bolt nuts equally. Refer to "FRONT SPRINGS" (SEC. 3C) for U-bolt torque specifications. Generally, if the axle is twisted, the caster will be unequal for right and left side.

CHECKING AND CORRECTING CASTER

IMPORTANT: Caster, camber, and toe-in dimensions are for vehicle carrying its design load whereby the frame in most instances would be level. If alignment check is to be made with frame NOT LEVEL the frame angle (fig. 2) must be determined and added to the caster angle to obtain a

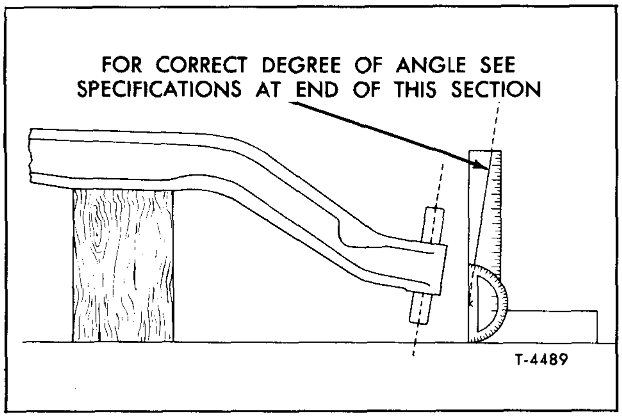


Figure 3—Checking King Pin Inclination Using Square and Protractor

true caster reading.

IMPORTANT: The corrected caster procedure following does not apply to vehicles equipped with "non-symmetrical" front springs. Refer to "FRONT SPRINGS" (SEC. 3C) for illustration of a non-symmetrical-type spring. Vehicles so equipped should be checked for caster readings as directed for all vehicles, but corrections for frame angle should be disregarded.

NOTE: On FE970 axle the minus "1" degree caster (truck loaded) provides the easiest steering -- least steering effort with adequate return. The "0" degree caster (truck loaded) requires more steering effort and has faster recover. Greater negative caster can lead to unstable behavior along with harder steering and still faster recovery. These factors should be considered when making alignment adjustments.

1. Position vehicle on a smooth level surface.

2. Using a bubble protractor (fig. 2), measure the frame angle (FA). Frame angle is the degree of tilt in the frame from the level position. Negative frame angle is when the frame is high (above level) in the rear. Positive frame angle is when the frame is low (below level) in the rear.

3. Determine the caster angle for the left wheel using the alignment equipment.

4. Add the frame angle (FA) found in step 2 to the left wheel caster reading found in step 3 to determine the "corrected caster" for left wheel.

To determine "corrected caster" with various frame and caster readings the following rules apply:

(a) Negative frame angle must be added to positive caster reading.
(b) Positive frame angle must be subtracted from positive caster reading.
(c) Negative frame angle must be subtracted from negative caster reading.
(d) Positive frame angle must be added to negative caster reading.

Example: An HM-7500 with F070 axle and power steering has a left wheel caster reading of 2° positive, but the frame angle is negative (high in the rear) $\frac{1}{2}^{\circ}$; therefore, $\frac{1}{2}^{\circ}$ negative frame angle plus 2° positive caster gives $2\frac{1}{2}^{\circ}$ positive as the "corrected caster" for that wheel. Referring to "Specifications," we find that $2\frac{1}{2}^{\circ}$ positive caster is within the specified setting.

5. Repeat steps 2 through 4 for the right wheel.

6. If the caster is not within specifications, caster can be corrected by adding or removing caster shims between the axle and spring.

KING PIN INCLINATION

King pin inclination is the amount that top of king pin is inclined toward center of vehicle. King pins are inclined (B, fig. 1), to decrease friction between tires and road when turning. Precision instruments must be used to check king pin inclination when axle is installed in vehicle. When axle is removed, check can be made on bench as follows:

Referring to figure 3, place two uniform blocks on flat surface and rest spring seats on blocks. Using a square and protractor as shown, project the proper degree line (see "Specifications") from center reference point of protractor to upper end of square. Place square on bench adjacent to axle king pin. Measure distance from king pin at top and bottom to scribed line on square. If a difference is noted, axle is sprung. To determine degree of distortion, subtract smaller reading from larger. Straightening of axle center to correct king pin inclination will also change the camber. Recheck camber after correcting king pin inclination. If axle is bent or twisted, refer to "FRONT AXLE" (SEC. 3B) for corrective information.

FRONT END ALIGNMENT SPECIFICATIONS

TRUCK MODEL	CAMBER L.H.	CAMBER R.H.	CASTER MANUAL & POWER	TOE IN WHEEL (Inch)	TOTAL TOE IN (Inch)	AXLE	*TURNING ANGLES IN-SIDE	*TURNING ANGLES OUT-SIDE	KING PIN INCLINATION LEFT	KING PIN INCLINATION RIGHT
HM80	1° 30′±30′	1° 30′±30′	2° 48′±30′	1/16 to 1/8	1/8 to 1/4	F-070	39°	28° 43′	7°	7°
HM80	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
HV70	1° 30′±30′	1° 30′±30′	2° 48′±30′	1/16 to 1/8	1/8 to 1/4	F-070	39°	28° 43′	7°	7°
	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-120	39°	28° 30′	5.45°	6.15°
JM80	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-120	39°	28° 30′	5.45°	5.15°
	1°±30′	1°±30′	1°±30′	1/16 to 1/4	1/8 to 1/4	F-160	39°	27° 45′	8°	8°
JV70	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-120	39°	28° 30′	5.45°	6.15°
TM80A	0° 15′±30′	−0° 15′±30′	0°+30′, 0°−0′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
	0° 15′±30′	−0° 15°±30′	0°+30′, 0°−0′	1/16 to 1/8	1/8 to 1/4	F-120	39°	27° 45′	5.45°	6.15°
TV70	1° 30′±30′	1° 30′±30′	1° 15′±30′	1/16 to 1/8	1/8 to 1/4	F-070	39°	27° 45′	7°	7°
	0° 15′±30′	−0° 15′±30′	1° 15′±30′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
	0° 15′±30′	−0° 15′±30′	1° 15′±30′	1/16 to 1/8	1/8 to 1/4	F-120	39°	27° 45′	5.45°	6.15°
HI90	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
HN90	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-120	39°	28° 30′	5.45°	6.15°
JI90	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
JN90	0° 15′±30′	−0″ 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-120	39°	28° 30′	5.45°	6.15°
	1° 30′±30′	1° 30′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-160	39°	27° 45′	8°	8°
MH90	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-090	39°	27° 45′	5.45°	6.15°
MI90	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-120	39°	28° 30′	5.45°	6.15°
FC/FH/FI/FN	0° 15′±30′	−0° 15′±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-120	39°	28° 36′	5.45°	6.15°
DC/DH,DI/DN90	1°±30′	1°±30′	1°±30′	1/16 to 1/8	1/8 to 1/4	F-160	39°	27° 45′	8°	8°
Some Models	0°+30′	0°−30′	1°±30′	1/16 to 1/8	1/8 to 1/4	FE-900	—	—	6°	7°
(Special Equipment)	1°±30′	1°±30′	0°−1°	—	.06±.06	FE-970	—	—	1°	1°

*Regardless of maximum turning angles specified, adjustment of stop screws must provide 5/8-inch minimum clearance of tire with any chassis components.

FRONT AXLE

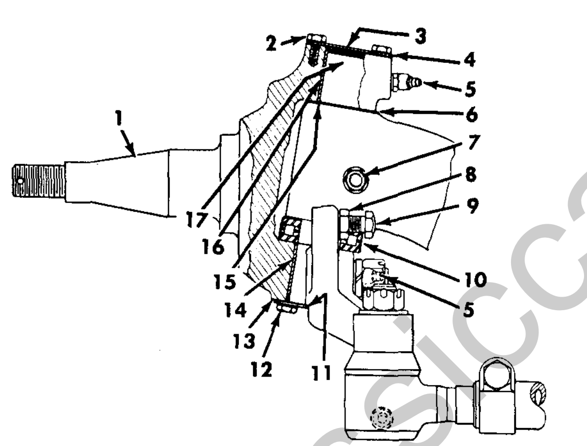
Reference is made to axle models in this section. Specifications are listed at the end of this section for each axle model. For truck series application, refer to "Model Data" at the front of this manual.

Axle steering knuckles are constructed as shown in figures 1, 2, and 3. Wheel bearings, springs, steering, and brake parts which are mounted on front axle are described in their respective section in this manual.

FRONT AXLE CONSTRUCTION

Front axle center section is one-piece steel forging with I-beam section in which dowel pins are installed to locate spring seats. Outer ends of axle center are machined to accommodate steering knuckles and king pins.

The centerpoint steering type axle (FE-970) (fig. 3) is used on some models. The term "centerpoint steering type" indicates that king pin pivot point is in direct line with center of tire.



1 Steering Knuckle
2 Cap Screw
3 Upper King Pin Bearing Cap
4 King Pin Bearing Cap Gasket
5 Lubrication Fitting
6 Shim
7 Draw Key
8 Stop Screw Lock Nut
9 Stop Screw
10 Thrust Bearing
11 Lower King Pin Bearing Cap
12 Cap Screw
13 King Pin Bearing Cap Gasket
14 Lower Bushing
15 O-ring Seal
16 Upper Bushing
17 King Pin

T-2889

Figure 1—Steering Knuckle Construction (Corp. F070 Axle)

A straight-type king pin is employed and is retained to the axle center with two tapered draw keys. A flat metal cap and a gasket, which are secured to top of knuckle with two screws, prevent dust and moisture from entering the upper bushing. A snap ring retained expansion plug serves the same purpose at knuckle lower bushing.

The vertical thrust load on front axle is carried on roller-type shielded bearing located between the axle center and lower portion of each knuckle.

Periodically check steering knuckle bushings for wear and also check the knuckle-to-axle center draw keys for looseness. Oversize (taper only) draw keys are available if the keys should become loose and the holes enlarged. Refer to figure 4.

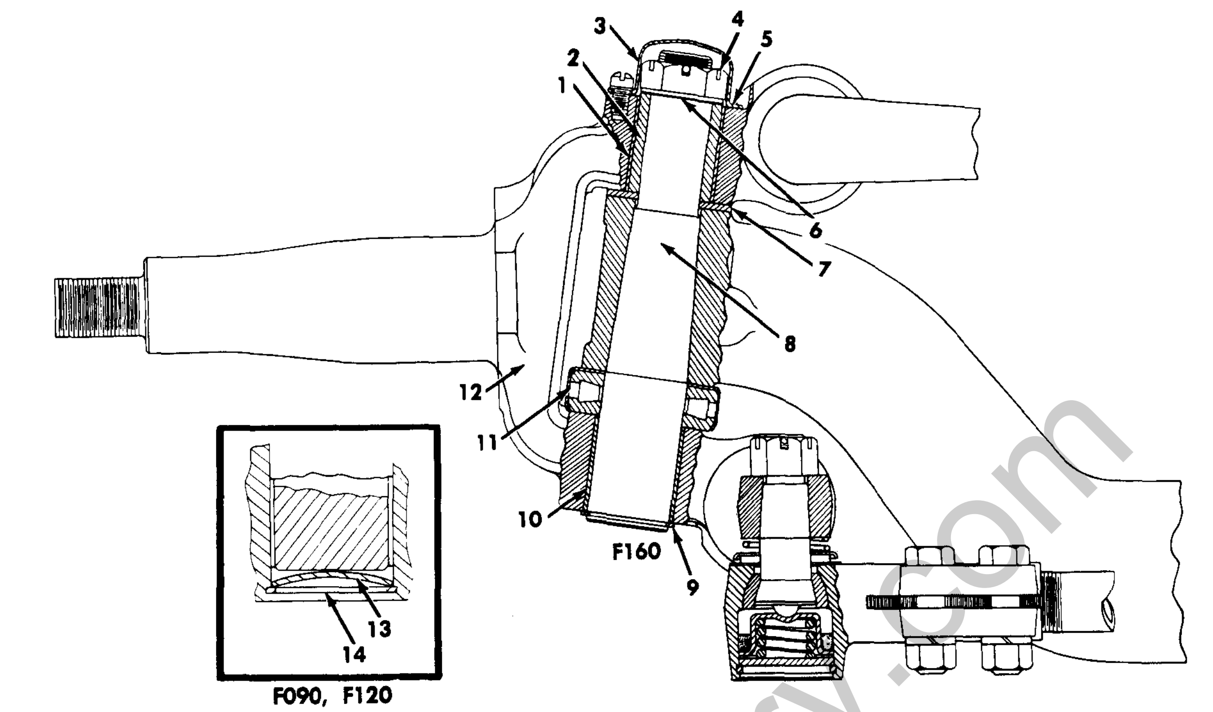
NOTE: The shorter draw key is used in the upper position.

Check the vertical movement of knuckle in relation to axle center. If movement exceeds 0.005" add one or more service shims between axle center and upper portion of knuckle. Shims are available in 0.005", 0.010" and 0.015" thickness.

FRONT AXLE GENERAL MAINTENANCE

Following maintenance operations should be performed at intervals determined by severity of service:

1. Inspect spring U-bolts for tightness. If loose, tighten as directed in "FRONT SPRINGS" (SEC. 3C) later in this group.
2. Tighten steering arm and tie rod end stud nuts to torque specified in STEERING SYSTEM (SEC. 9) of this manual.
3. Lubricate front axle parts as instructed in LUBRICATION (SEC. 0) of this manual. When lubricating front axle parts, observe condition of seals at tie rod ends. If seals are found to be damaged or missing, new seals should be installed immediately. Refer to STEERING SYSTEM (SEC. 9).
4. Examine steering knuckle bearing caps for tightness and evidence of lubricant leakage. Tighten or replace parts as required with genuine GMC replacement parts.
5. On F-070 Corporation axle, inspect and tighten king pin draw key nuts. Loose draw keys will permit king pin to turn in axle center, thus enlarging king pin hole. If hole becomes too greatly enlarged, replacement of axle center may be necessary. If draw key holes become enlarged beyond use of new key, replace axle center. IT IS NOT



1 Knuckle Upper Bushing
2 King Pin Bushing
3 Upper Dust Cap
4 King Pin Nut
5 Dust Cap Gasket
6 Spacer
7 Spacing Washer
8 King Pin
9 Knuckle Lower Bushing Retaining Ring
10 Knuckle Lower Bushing
11 Thrust Bearing
12 Knuckle
13 Lower Expansion Plug
14 Expansion Plug Lock

T-7057

Figure 2—Steering Knuckle Construction (F090, F120, and F160 Axle)

SAFE TO REAM AND BUSH DRAW KEY HOLES.

6. Inspect kingpin and steering knuckle bushings for wear.

7. Check up and down movement of knuckles on kingpins. Excessive movement will pound and damage the thrust bearings. Refer to "Specifications" for maximum axle-to-knuckle clearance.

8. Check stop screws and adjust when necessary.

9. When steering difficulty or abnormal tire wear is indicated, check front end alignment as previously instructed under "FRONT END ALIGNMENT" (SEC. 3A).

STOP SCREWS

Adjustable stop screws are located between each steering knuckle and axle center to prevent wheels from contacting chassis on extreme right and left turns. The stop screws are installed in the steering knuckles and stop against the axle center as shown in figure 5 on F-070, F-090, F-120 and FE-970 axles. On F-160 axles, stop screws are installed on axle center and stop pads are on steering knuckle.

Steering gears are equipped with built-in stops to prevent steering mechanism from bottoming at extreme turns. Screws are set to obtain the maximum turning angles provided in these models. Refer to "Specifications" in Sec. 3A for turn angles.

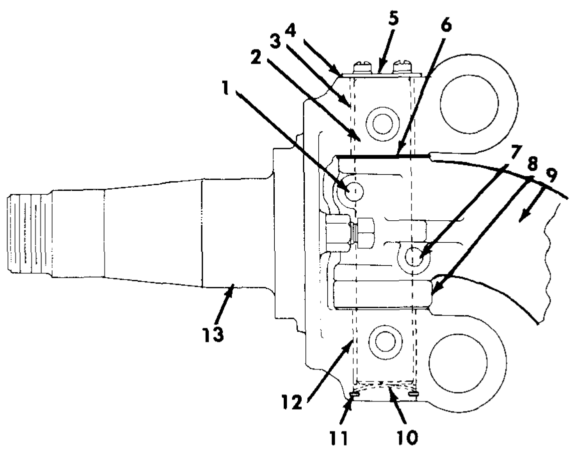
1. Pitman arm must be installed correctly on steering gear. Refer to STEERING SYSTEM (SEC. 9) of this manual for installation instructions.

2. Turn in the right stop screw so that screw will not contact its stop when wheels are turned to extreme right.

3. With wheels turned to extreme right, hold right wheel tightly against right turn position, then turn out stop screw until it contacts firmly against its stop. Turn screw about 1 turn more against its stop, and tighten lock nut. Check position of tire. If tire has less than 5/8" clearance from any chassis obstruction, adjust screw to obtain clearance.

4. Repeat steps on left side.

IMPORTANT: When installing oversize tires, recheck turning clearance and stop screw setting.



1 Upper Draw Key (Short)	7 Lower Draw Key
2 King Pin	8 Thrust Bearing
3 Upper Bushing	9 Axle Center
4 Cap Gasket	10 Expansion Plug
5 King Pin Cap	11 Lock Ring
6 Spacing Shim	12 Lower Bushing
	13 Steering Knuckle

T-4334

Figure 3—Steering Knuckle (FE970 Axle)

FRONT AXLE REPLACEMENT

All component parts of the front axle assembly except axle center can be replaced without removing assembly from vehicle, if necessary. Minor straightening with suitable equipment can be accomplished with assembly in vehicle. When the front axle requires a complete overhaul, the assembly can be replaced as described following:

NOTE: The letter "F" is stamped on front of spring pad on F-090 and F-120 Series axles; this indicates front of axle. If this identification mark is not visible, make a punch mark on front of spring pad before removing ends from I-beam. If I-beam is not marked, it could be installed backwards, and camber would be wrong.

REMOVAL

1. Jack up and support vehicle frame to relieve load from springs.
2. Remove wheels and hubs. Disconnect brake lines at axle. Disconnect drag link from steering arm.
3. While supporting axle center with suitable jack, remove spring U-bolts. Lower assembly and remove from under vehicle.

INSTALLATION

1. Place assembly on dolly and roll into position under vehicle. Raise axle up against springs, making sure spring center bolts enter alignment holes in spring seats. Be sure caster angle shims if used, are in place between spring and axle with thick edge facing correct direction (see "FRONT SPRINGS" (SEC. 3C) later in this group). Attach axle to springs, tightening U-bolts as described in "FRONT SPRINGS" (SEC. 3C).
2. Install hubs and bearings as described in "FRONT HUBS AND BEARINGS" (SEC. 3D). Connect drag link as directed in STEERING SYSTEM (SEC. 9) of this manual. Connect brake lines. If hydraulic brakes are used, bleed brakes as described in "HYDRAULIC BRAKES" (SEC. 5A).
3. Check stop screws and adjust as previously described. Check front end alignment and adjust.

FRONT AXLE OVERHAUL

Steering knuckles, king pins, bushings, and thrust bearings can be replaced without removing front axle from vehicle. Minor axle straightening can also be accomplished without removing assembly from vehicle. Preliminary inspection can be made while axle is still mounted. These inspections should aid in determining the amount of repair necessary. Check front end alignment as directed previously under "FRONT END ALIGNMENT" (SEC. 3A). Inability to correctly align wheels indicates that the axle center or steering knuckle is distorted, tie rod bent, or knuckle bushings are worn beyond limits. If axle is believed to be bent or warped it may be checked when removed from vehicle by following instructions in Section 3A. Precision equipment is necessary to check axle on vehicle.

STEERING KNUCKLE (CORP. F070 AXLE)

DESCRIPTION

The king pin is held in place with a tapered draw key, installed as shown in figure 1. The draw key is retained in place by a lock washer and nut. Steering knuckles are equipped with Delrin bushings. Upper and lower ends of knuckles are sealed with king pin bearing caps and gaskets and an O-ring seal at the bottom of the upper bushings, to prevent lubricant leakage and to exclude dirt and moisture. The vertical thrust loads are carried by thrust bearing installed between lower face of axle center and steering knuckle lower yoke. Lubrication fittings are provided at upper and lower ends of knuckle.

REMOVAL

1. Jack up axle and remove hubs and bearings as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D). Remove brake backing plate from steering knuckle. Remove tie-rod as directed in STEERING SYSTEM (SEC. 9) of this manual.

2. Remove steering arm from steering knuckle.

3. Remove kingpin draw key nut and washer. Thread nut on draw key far enough to protect the threads. Strike nut with hammer to loosen draw key. Remove nut, then drive pin out with brass drift and hammer.

4. Remove cap screws attaching upper and lower kingpin bearing caps and gaskets to steering knuckle, then remove caps and gaskets.

5. Using brass drift and hammer drive king pin out of axle.

6. Remove steering knuckle thrust bearing, shims, and O-ring.

7. Refer to "Inspection and Repair" later in this section for inspection and repair procedure.

INSTALLATION

1. Before assembly, thoroughly clean all parts; then coat kingpin with light coat of S.A.E. 10 engine oil.

2. Position steering knuckle on axle, then insert the thrust bearing into place.

3. Install a new O-ring seal at bottom of upper bushing.

4. Align king pin holes in steering knuckle yoke, axle end, and thrust bearing; then partially install kingpin through top.

5. With axle center held firmly, place a jack under steering knuckle; then raise until all clearance between knuckle lower yoke, thrust bearing and axle center is taken up. Check clearance between top of axle center and knuckle upper yoke. If clearance exceeds 0.005", place a shim between axle center and knuckle upper yoke.

6. Install king pin, with milled slot in side of pin registering with draw key hole in axle center. Install king pin from top, inserting through steering knuckle yoke, shim, thrust bearing and axle center end. Press pin down until milled slot in pin lines up with draw key hole.

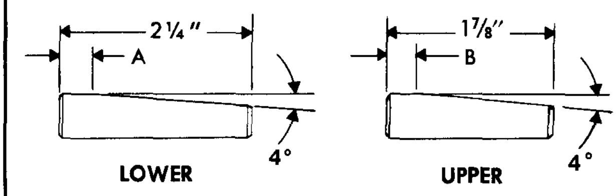
7. Insert draw key into axle center, registering with king pin, then install lock washer and nut. Tighten nut firmly. If nut bottoms on knuckle before king pin is secure, replace draw key or use a draw key with more taper.

8. Install new gaskets, then install upper and lower king pin bearing caps with cap screws. Tighten cap screws to torque listed in "Specifications."

9. Lubricate king pins thoroughly through lubrication fittings as directed in LUBRICATION (SEC. 0) of this manual. Try action of steering knuckle for binding condition.

10. Install steering arms to knuckles. Install tie-rod as directed in STEERING SYSTEM (SEC. 9) of this manual. Install brake backing plate assembly. Install hubs and bearings and wheels as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D).

11. Check front end alignment and stop screw adjustment as previously directed.



A	GM Part No.	B	GM Part No.
0.44"	2442135	0"	319401
0.56"	2442136	1/8"	319390
0.69"	2442137	1/4"	319400

Select the proper size draw key to obtain the following condition when fully installed:

Large end of key must be recessed into axle center hole no less than 1/8-inch or no more than 3/8-inch. With key installed, stake around draw key hole as shown in view below:

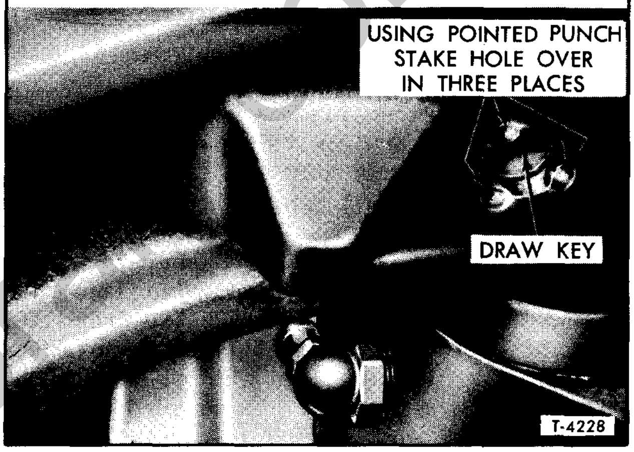
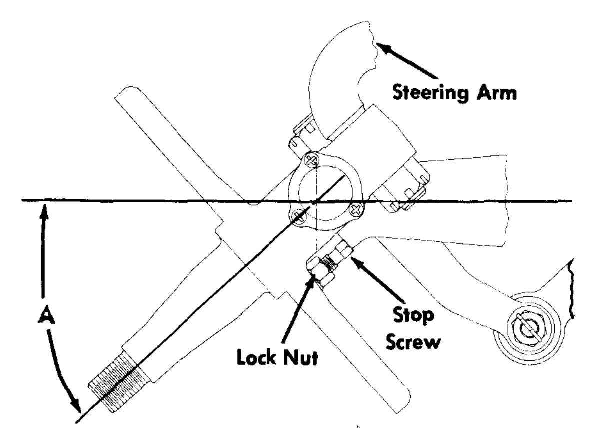


Figure 4—King Pin Draw Keys (FE970 Axle)

STEERING KNUCKLES (F090, F120, AND F160 AXLES)

NOTE: Key numbers in following text refer to figure 2.

The steering knuckles are supported on solid king pins which are tapered at center section to fit snugly in tapered holes in axle center outer ends. A steel sleeve bushing (2) is mounted between the knuckle upper Delrin bushing (1) and the king pin to maintain the same size bearing at top and bottom. Bushings are split Delrin and are of floating type.



A—Dimension varies with different size tires. Set stop screws to provide $\frac{5}{8}$" clearance between tires and chassis at extreme turn positions. TPM-7608

Figure 5—Typical Steering Knuckle

Bushings are held in place at upper end by the king pin nut and spacer (6). Vertical thrust is taken by a roller-type thrust bearing (11). Thrust movement is held to a minimum by the use of spacing washers (7) between upper knuckle yoke and axle center end. Upper end of knuckle pins are sealed with dust caps and gaskets, retained in place with screws. Lower end of knuckle on F-090 and F-120 axles (inset, fig. 2), are sealed with an inverted expansion plug held in place with a lock ring. On F-160 axles a retaining ring is installed on lower end of king pin (fig. 2) to retain king pin bushing. Right and left steering arms are keyed to knuckles, and retained in place with nuts and cotter pins.

STEERING KNUCKLE
REMOVAL (Fig. 2)

If desired, steering knuckles may be removed from front axle without removing front axle assembly from the vehicle. To remove steering knuckles from the axle either with or without removing the front axle assembly from the vehicle, proceed as follows:

1. Remove hubs, bearings, and brake mechanism. Disconnect tie rod and drag link from arms.
2. Remove cap screws which attach dust cap and gasket to knuckle.
3. On F-090 and F-120 axles (inset, fig. 2), remove the lower expansion plug lock ring and plug. On F-160 axles (fig. 2), a king pin bushing retaining ring is located at lower end of king pin. The purpose of this ring is to keep steering knuckle lower bushing in place. Do not remove ring unless ring is broken or damaged.
4. Remove cotter pin, king pin nut, and steel spacer (6). Using suitable brass drift, drive the king pin downward out of axle and knuckle. Remove knuckle, thrust bearing (11), and spacing washer (7) from the axle. Sleeve bushing (2) can now be removed.

STEERING KNUCKLE
INSTALLATION (Fig. 2)

The importance of cleanliness when assembling steering knuckle parts cannot be overstressed. If king pins and bushings are installed with particles of dirt or metal between bearing surfaces, excessive wear will result, necessitating premature replacement of parts.

1. Refer to "Inspection and Repair" for inspection and repair procedures.
2. Position knuckle to axle center; then slide thrust bearing assembly between lower face of axle center and steering knuckle lower yoke. Make certain the retainer is on top of bearing with lip of retainer down. Align king pin holes in knuckle yoke with king pin hole in axle center.
3. With axle center held rigidly, place a jack under knuckle yoke, then raise knuckle sufficiently to take up all clearance between lower yoke, thrust bearing, and lower face of axle center end.
4. Check clearance between top face of axle center end and face of knuckle yoke. Select shims or spacing washer (7) of correct size to provide thrust clearance listed in "Specifications" at end of this section. These are available in different thicknesses.
5. Make certain king pin hole in axle center, the king pin, and nut are clean and dry. King pin nut should thread on king pin freely without bind.
6. Insert king pin through bottom yoke of knuckle; then drive pin into place with lead hammer. Place king pin sleeve bushing (2) over king pin, then press into place. Be sure sleeve bushing is installed flush with pin. Install steel spacer (6) on top of bushing.
7. Make sure threads on king pin and nut are clean and dry; then install king pin nut. Tighten nut to minimum torque specified in "Specifications"; then tighten nut until next slot on nut lines up with cotter pin hole through king pin. Install new cotter pin, full size of hole.
8. On F-090 and F-120 axles (inset, fig. 2), install new inverted expansion plug in lower hole. Install plug lock ring, seating ring securely in groove.
9. On F-160 axles, if lower bushing retaining ring (9) is bent or damaged, replace ring.
10. Install new king pin dust cap gasket (5) at top; then install dust cap (3). Tighten screws firmly.
11. Connect tie rod and drag link to steering arms. Install brake mechanism and hubs. Check front end alignment factors and stop screw setting.

12. Lubricate knuckles as directed in LUBRICATION (SEC. 0).

STEERING KNUCKLE (FE970 AXLE)

REMOVAL

1. Safely support axle, then remove hubs and bearings as directed under "FRONT HUBS AND BEARINGS" (SEC. 3D).
2. Remove tie rod from one or both steering arms.
3. Remove two special screws which attach king pin dust cap to top of steering knuckle. Remove cap and cap gasket.
4. At bottom of king pin, remove lock ring and expansion plug. If plug cannot be readily removed, it will come out later when king pin is driven from knuckle.
5. Using a suitable drift, drive out the two draw keys by placing drift against small end of each key.

NOTE: Keys were originally installed from opposite sides of center.

6. With axle components properly supported, drive the king pin downward using a brass driving bar or drift.
7. Remove knuckle, thrust bearing and spacing shim(s).

STEERING KNUCKLE INSTALLATION

1. Make sure that king pin hole in axle center is clean and dry, then position and support knuckle on the axle center.
2. Slide the thrust bearing between axle center and knuckle lower yoke.

NOTE: Thrust bearing must be positioned with retainer lip down.

3. Place a jack under the knuckle and raise knuckle so that all clearance is taken up at thrust bearing.
4. Check the clearance between knuckle upper yoke and axle center. The clearance must not exceed 0.005 inch. Spacing shims are available in 0.005", 0.010" and 0.015" thickness.
5. After positioning the proper shim, align the flats on king pin to align with draw key holes in axle center then drive the king pin through knuckle bearing, shims and axle center until draw key holes are in alignment.
6. Draw keys are available in three different sizes as shown in figure 4. Select the draw key to obtain the following condition when fully installed:

Large end of key must be recessed into axle center hole no less than 1/8 inch or more than 3/8 inch.

NOTE: The short key is installed in upper hole and the long key in lower hole.

IMPORTANT: DO NOT INSTALL BOTH KEYS FROM SAME SIDE OF AXLE CENTER.

7. After selecting proper key, peen or prick punch edge of hole as shown in figure 4.
8. At bottom of knuckle, install expansion plug and plug lock ring.
9. Install king pin dust cap and gasket to knuckle with two special retaining screws.
10. Install steering tie rod, hubs and brakes and all other adjacent components previously removed.

FRONT AXLE SPEEDOMETER DRIVE (SOME VEHICLES)

Some vehicles are equipped with front wheel speedometer drive as shown in figure 6. The larger gear which is secured to the hub by a light press fit and with three small equally spaced setscrews, drives the smaller driven gear which in turn drives the speedometer cable through an adapter. The smaller driven gear and eccentric assembly is attached to the brake backing plate or adapter plate

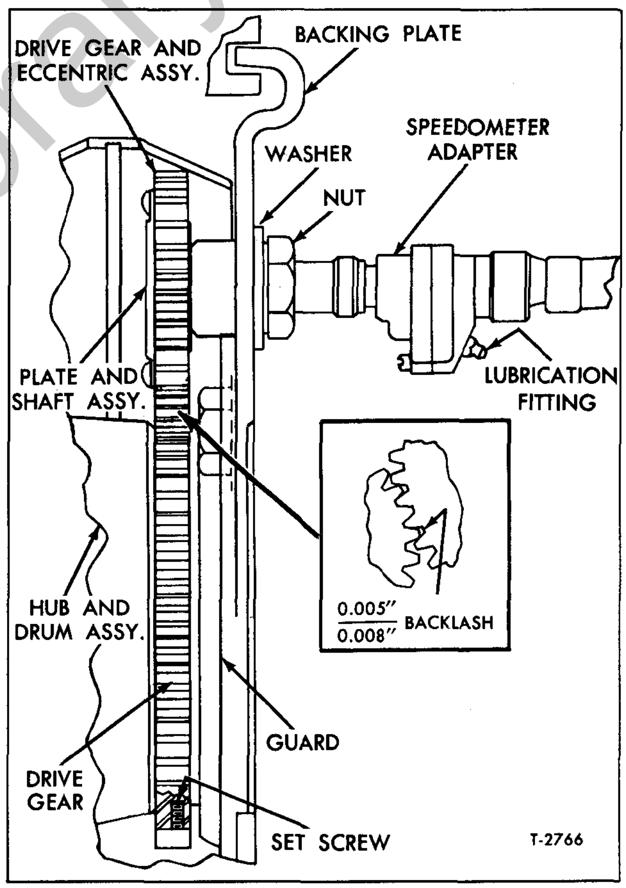


Figure 6—Front Wheel Speedometer Drive

with a hex nut and lock washer. The speedometer cable adapter is then threaded to the eccentric portion of the gear assembly. The eccentric when rotated will serve to provide required backlash clearance of 0.005" to 0.008" between the drive and driven gear teeth. Periodically this clearance should be checked and, if necessary, adjusted as follows:

GEAR BACKLASH CHECK
AND ADJUSTMENT

1. Block wheels of vehicle, then raise and safely support axle and wheel.

2. Disconnect the speedometer cable adapter from the eccentric at threaded connector.

3. With the adapter drive key located within the eccentric, rotate key back and forth noting the approximate amount of backlash by feel.

IMPORTANT: Make check at each ¼ turn of hub. If a noticeable difference in clearance is detected in any one of the four positions, it is necessary to remove the hub and check the position of all three set screws which attach drive gear to hub. If any one screw is turned in beyond a snug set, a tendency to separate the gear from hub will occur, resulting in a "high spot" against the drive gear. However, in event a screw should loosen and work outward from gear, a bind will occur each rotation of drive gear at this particular location. All three screws should be tightened evenly and snug only against the hub.

4. If it is determined that excessive or insufficient backlash clearance exists, loosen hex nut at eccentric, then using wrench on flats, turn eccentric either direction until specified backlash clearahce is obtained. Tighten hex nut, install adapter key and connect the speedometer cable firmly.

IMPORTANT: If hub is removed at any time, the eccentric should be rotated to provide maximum distance from centerline of hub spindle befor hub is positioned back on spindle. The purpose is to avoid possible gear damage when gears are not completely in mesh when hub is installed.

INSPECTION AND REPAIR

Wash steering knuckle parts (except Delrin bushing), in cleaning solution, being sure to remove all dirt and lubricant. If necessary, soak thrust bearings in cleaner until all old lubricant is dissolved; then slush bearings in cleaning solution until all grit is removed.

CAUTION: Delrin bushings must not be washed in Keytone or chlorinated solvent.

CAUTION: Avoid turning bearings in races when bearing assemblies are dirty, since small particles of grit will damage bearings. "Specifications" at end of this group itemize the various fits and tolerances which apply to all front axles covered by this manual. It is recommended that all parts which do not meet these specifications be replaced with genuine Chevrolet replacement parts.

1. Steering Knuckles. After steering knuckles have been cleaned thoroughly, examine knuckles for distortion, damage, cracks, or fractures. If Magna-Flux inspection equipment is available, use this method to inspect steering knuckles and king-pins for minute cracks, checks, or fractures which otherwise would not be visible to the naked eye.

2. Thrust Bearing. Examine thrust bearings for excessive wear, pitting, or other damage. If these conditions are evident or if bearing retainers are bent or damaged, bearings should be replaced.

3. Steering Knuckle Bushings. Replace steering knuckle bushings if wear is indicated, or if results given previously under "Front Wheel Camber" in "FRONT END ALIGNMENT" (SEC. 3A), indicates replacement is necessary.

a. Bushing Removal. Bushings are split Delrin floating-type. To remove, slide bushings out of knuckle bore.

b. Bushing Installation. When installing bushings, remove nicks and burrs from knuckle bushing bore and polish with medium grit abrasive paper or cloth. Apply lubricant specified in LUBRICATION (SEC. 0) of this manual, to all parts and install the bushings in the knuckle bores.

4. King pin Inspection. Check diameter of king pin. Also, check for minute cracks or other damage. If inspection reveals excessive wear, replace king pin.

5. Axle Center. There are two conditions which, if either exists, will necessitate replacement of axle center.

a. If king pin holes in axle center ends are worn to such an extent that a new or oversize king pin fits loosely, axle center must be replaced.

b. If axle center has been twisted or bent more than 5 degrees from original shape, the center should be replaced. When an extreme bent condition exists, minute invisible fractures may occur and cause failure under ordinary operating conditions.

Check axle center for twist with alignment instruments, or on a bench as illustrated in Front End Alignment Chart (fig. 1). If equipment is available, use Magna-Flux method to check axle center for minute fractures.

SPECIFICATIONS

AXLE SPECIFICATIONS

AXLE MODEL	F070	F090	FE900	FE970
KING PIN				
Length	7 57/64"	8 3/4"	9 3/4"	8 13/16"
Diameter				
At Top	1.2492"-1.2496"	1.1855"-1.1865"	1.3095"-1.3085"	1.6070"-1.6060"
At Bottom	1.2492"-1.2496"	1.4330"-1.4340"	1.6070"-1.6060"	
KING PIN BUSHING				
Length	—	1 29/32"	2 3/8"	0
Diameter				
Outer	—	1.4330"-1.4340"	1.6070"-1.6060"	0
Inner	—	1.1870"-1.1880"	1.297"-1.300"	0
STEERING KNUCKLE BUSHING*				
Length			2.22"	2.22"
Upper	1 7/8"	1.760"		
Lower	1 7/8"	2.150"		
I.D. When Installed	1.2496"-1.2526"	1.4340"-1.4370"	1.610"-1.607"	*1.610"-1.607"
STEERING KNUCKLE THRUST	0.005"	0.004"-0.012"	.005"	.005" Max.
SPACING WASHERS AVAILABLE	—	0.114"-0.116" White 0.121"-0.123" Yellow 0.128"-0.130" Blue	0.093"-0.125"	0 0 0
SPACING SHIMS AVAILABLE	0.005"	Use Spacing Washer	0.015"-0.010"	.005"-.010"-.015"
TORQUE SPECIFICATIONS				
King Pin Nut	—	250 Ft. Lbs. Then Advance to Next Cotter Pin Hole	350-390 Ft. Lbs.	— —
King Pin Bearing Cap, Cap Screw	60-70 In. Lbs.			60-70 In. Lbs.

AXLE MODEL	F120	F160
KING PIN		
Length	9 3/4"	10 11/16"
Diameter		
At Top	1.3085"-1.3095"	1.3085"-1.3095"
At Bottom	1.6060"-1.6070"	1.794"-1.793"
KING PIN BUSHING		
Length	2 3/8"	2 1/2"
Diameter		
Outer	1.6060"-1.6070"	1.7930"-1.7940"
Inner	**1.2970"-1.3000"	**1.3000"-1.3030"
STEERING KNUCKLE BUSHING*		
Length		
Upper	2 7/32"	2 9/32"
Lower	2 7/32"	2 9/32"
I.D. When Installed	1.607"-1.610"	1.7940"-1.7970"
STEERING KNUCKLE THRUST	0.015" Max.	0.015" Max.
SPACING WASHERS AVAILABLE	0.093"-0.125"	0.093"-0.125"-0.156"
SPACING SHIMS AVAILABLE	0.010"-0.015"	0.010"-0.015"
TORQUE SPECIFICATIONS		
King Pin Nut	250 Ft. Lbs. Then Advance to Next Cotter Pin Hole	250 Ft. Lbs. Then Advance to Next Cotter Pin Hole
King Pin Bearing Cap, Cap Screw	—	—

*Delrin Bushing—No Finishing Required
**Ream after Installation

FRONT SPRINGS

DESCRIPTION

Standard front springs on all models covered in this manual are of multi-leaf two-stage design. The first stage of spring provides soft ride while empty. When loaded, weight of vehicle forces first stage spring leaves to contact second stage spring leaves by this method additional support from spring is gained.

Springs are attached to front axle center with U-bolts, and secured to frame rails as shown in figures 1, 2, and 3. U-bolts may also secure shock absorbers, tow eyes, and power steering cylinder brackets when used. Spring eyes on all models are equipped with replaceable bushings.

Front springs which employ rubber mounted bushings with solid eye bolt, require no lubrication at bushing.

Optional tapered two and three leaf type springs may be used on some models. The tapered spring makes use of Delrin liners, one between each leaf, and at top and bottom of spring pile as shown in figures 4 and 5. Bushings are of steel-backed bronze construction and are replaceable using conventional methods. Spring leaves of three-leaf tapered spring are secured together with a single center bolt and nut. The two leaf tapered spring makes use of raised nibs to center and retain leaves in correct alignment.

Front end of spring used on Alum. Tilt Models is fastened to hanger with spring eye pin, and an eye bolt and nut is used on 90 models. Rear of spring is shackle mounted to frame bracket. Two types of shackles are used, one is the unitized type, and the other is comprised of several components.

Periodic lubrication of spring eye is required at front and rear of spring.

GENERAL SPRING MAINTENANCE

LUBRICATION

Spring leaves (except optional two- and three-leaf type) are lubricated at time of assembly, and require no further lubrication unless spring is disassembled. Shackle and bracket pins, or bolts are equipped with lubrication fittings. Refer to LUBRICATION (SEC. 0) of this manual.

TIGHTENING

At regular intervals, spring U-bolts should be checked and tightened if necessary to torque listed in "Specifications" at end of this section.

CAUTION: U-bolts must be kept tight at all times to hold axle in place at springs. Otherwise axle may shift, causing misalignment or spring leaf failure in the vicinity of the spring center bolt could result.

The center bolt serves only to hold the spring together while in shipment and during installation and as a locating point when assembling spring to axle. After assembly it is the function of the U-bolts to hold spring and axle in alignment. The importance of keeping U-bolts tight cannot be overemphasized.

Check and tighten if necessary all spring shackle or bracket bolts and nuts, and shackle or bracket pin bolt clamps. Rebound clips should be tightened just enough to hold spring leaves in alignment, without restricting free movement of leaves.

REPAIR OPERATIONS

FRONT SPRING REMOVAL
- MULTI-LEAF TYPE (Figs. 1 and 2)

All Conventional 70-90
and Steel Tilt 80 Models

NOTE: Optional tapered two-leaf spring used on some 9502 models may be removed in same manner as multi-leaf spring.

1. Raise vehicle frame to take weight off spring. Make sure vehicle is supported safely.
2. Support axle on floor jack.
3. Remove spring to axle U-bolt nuts, then lower axle.
4. At front of vehicle, remove spring eye bolt nut and washer; withdraw eye bolt from bracket and spring eye.

NOTE: On some optional multi-leaf springs, a special flat washer must be removed from bolt spacer at each side of spring eye as shown in figure 2.

5. On 80 Tilt Cab Models, lower the spring out of rear bracket.
6. If shackle links are used, remove shackle nuts, shackle links, and pins. Then remove spring, caster spacer, tow eye (if used) and dowel pins (when used) (fig. 6).

NOTE: Refer to figure 6 for correct position of caster spacer for all vehicles at time of installation.

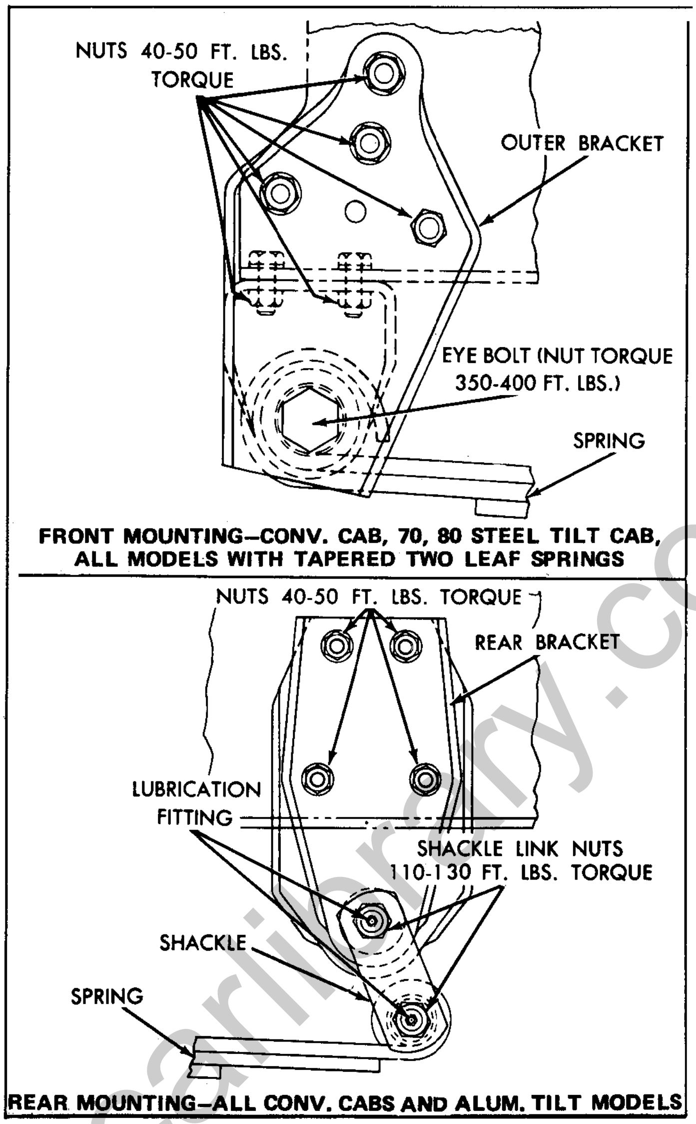


Figure 1—Front and Rear Mountings (Front Spring) (Typical)

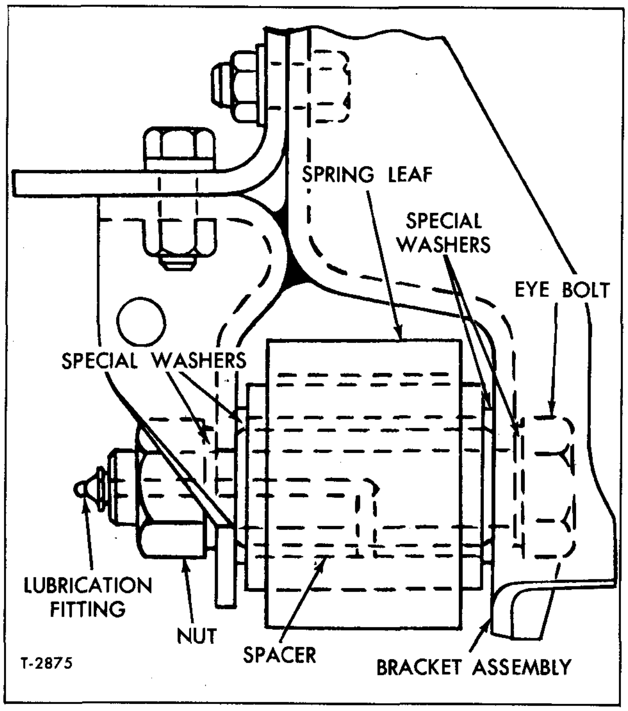


Figure 2—Steel Back Eye Bushing Installed

Aluminum Tilt 90 Models

NOTE: Key numbers in text refer to figure 3.

NOTE: Tapered and multi-leaf type springs may be removed from vehicle in same manner.

1. Raise frame to sufficient height to remove load from front spring. Safely block frame, then remove U-bolt nuts and washers.

2. Remove U-bolt (1) and upper U-bolt spacer (4), by telescoping shock absorber and spacer together, while raising the assembly from spring. If spacer bracket separation from shock absorber is desired it may be removed by removing retainer nut and washer, then forcing shock absorber eye with bushing from U-bolt spacer bracket.

3. At rear of spring, remove nuts and washers from shackle assembly (6).

NOTE: Refer to figure 8. This shackle consists of a unitized bracket and pin assembly which is tied together with a single link as shown in figure 8. Use of the new assembly simplifies repair operations, since fewer parts are used.

4. Drive shackle link assembly from rear hanger (5) and spring eye as shown in figure 3. DO NOT HAMMER ON LINK STUDS.

5. At front of spring, loosen or remove eye pin (8), clamp bolt (10), nuts and washers. With a suitable punch or drift tool, drive eye pin from hanger (9) and clamps.

NOTE: A puller tool (J-2619 with adapter J-553) is available for this purpose.

6. Remove spring from axle.

INSPECTION

1. Thoroughly clean the spring eye bushings, bracket or shackle bushings, and shackle or bracket bolt or pins to remove all old lubricant. Make sure lubrication passages in bolts and pins are open.

2. Insert bolts or pins into bushings in spring eyes, shackle, and bracket and check for looseness. If excessive looseness is evident, bolt, pin, or bushing must be replaced.

NOTE: If either leaf of the optional tapered two-leaf spring is broken, the complete spring assembly must be replaced.

3. Inspect spring assembly for broken leaves. Nos. 1 and 2 leaves can be replaced (except on optional tapered two-leaf). If other leaves are broken, replace complete spring assembly. Replace broken leaves as directed later in this section. All leaves of 3-leaf tapered spring may be replaced.

4. Inspect spring assembly for loose or broken rebound clips. Rebound clips should be tight enough to hold spring leaves in alignment, but not tight enough to restrict free movement of leaves.

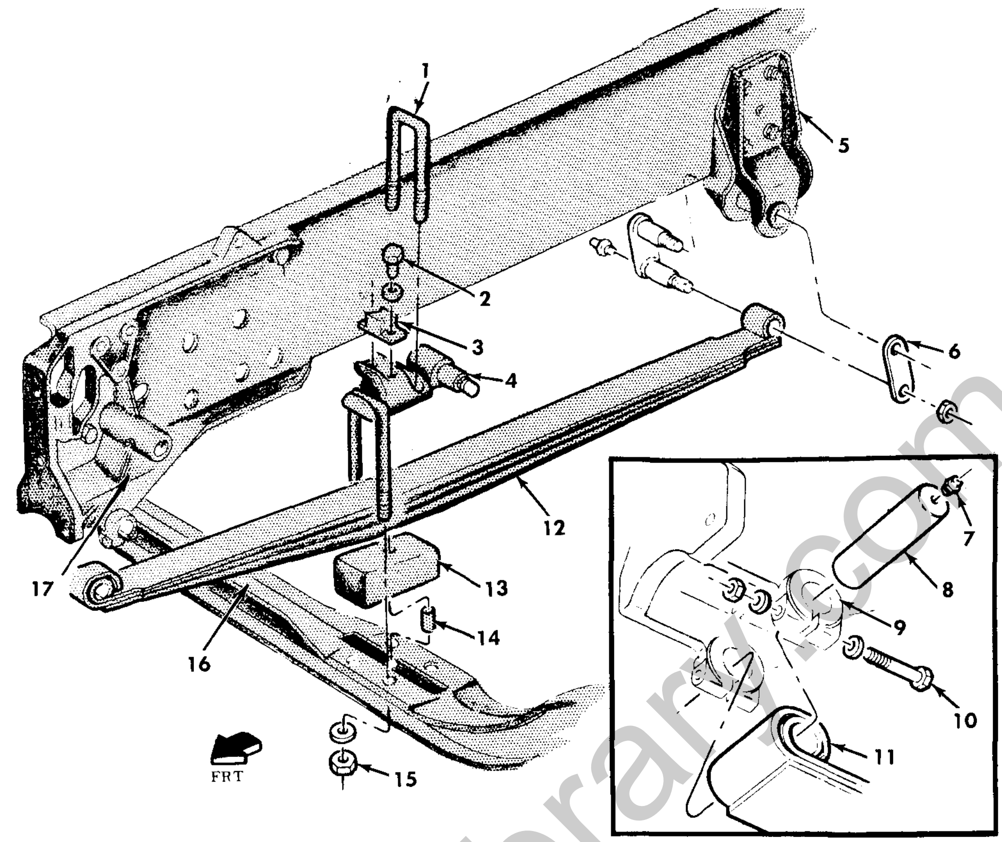
5. Check for broken or loose spring center bolt. Replace or tighten as necessary.

6. Inspect the inner leaf Delrin liners used on the optional tapered two- and three-leaf spring. If not in good usable condition, replace. Refer to "Specifications" at end of this section for thickness of liners. Center liner of two-leaf spring can be replaced as directed later under "Center Liner Replacement."

BUSHING REPLACEMENT

Rubber-Type Eye Bushing

Remove and replace front eye bushing using bushing remover and installer tool set (J-21058) as shown in figures 9 and 10.



1 Spring U-bolt	6 Rear Spring Shackle Link Assembly	12 Spring
2 Bolt	7 Lube Fitting	13 Caster Spacer
3 Bumper	8 Front Hanger Eye Pin	14 Dowel Pin(Except 9502)
4 U-bolt Spacer and Shock Absorber Mount	9 Front Spring Hanger	15 Nut
5 Rear Spring Hanger	10 Bolt	16 Axle
	11 Spring	17 Front Spring Hanger

T-6094

Figure—Three-Leaf Tapered Front Spring and Components (Alum. Tilt Series)

Plain-Bronze Bushing

Plain bushings are used in spring eyes and in shackles. Use suitable driver to press or drive worn bushings out and install new bushings. Bushings must be burnished or reamed to sizes specified in "Specifications" at end of this section. Test fit of bolts or pins in respective bushings before installing springs.

SPRING LEAF REPLACEMENT
(EXCEPT OPTIONAL TWO-LEAF TYPE)

1. Mark down one side of springs to assure original position of leaves, then place spring assembly in a vise or arbor press near center bolt.
2. When bolted type are used, remove rebound clip, nuts, bolts, and spacers.
3. File off peened end of center bolt, then remove nut and bolt.
4. Release vise or arbor press slowly to avoid possible injury. Separate spring leaves and clean thoroughly, using a wire brush if necessary.
5. Replace any broken rebound clips by cutting old rivet, and riveting new clip to spring leaf.
6. Replace broken leaf and stack leaves in correct order, applying a thin film of graphite grease to each leaf. Align center bolt holes in

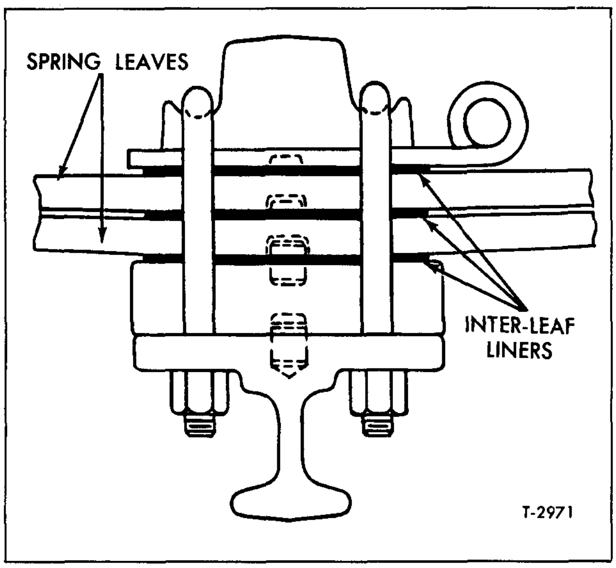


Figure 4—Two-Leaf Delrin Liners Installed

spring leaves with long drift, then compress spring leaves in vise or arbor press.

7. Install center bolt and nut and tighten firmly. Peen end of bolt to prevent nut loosening.

8. Remove spring from vise or arbor press. Align spring leaves by tapping with hammer. Install rebound clip, spacers, bolts, and nuts. Tighten enough to hold spring leaves in alignment, but not enough to restrict free movement of leaves.

TAPERED SPRING LEAF REPLACEMENT
(THREE-LEAF TYPE)

NOTE: Key numbers in text refer to figure 5.

To replace any spring leaf (other than bottom leaf) it is necessary to remove entire spring assembly from vehicle. Remove spring assembly as directed in the previously described "Spring Removal" procedure.

1. Position C-clamp of sufficient strength to safely hold spring on spring pile, adjacent to center bolt (7). Tighten clamp firmly.

2. Unfasten spring clips (2) at each end of spring and remove clips from spring.

3. File peened end of center bolt (7) and remove nut, then drive center bolt from spring.

4. Slowly release tension of C-clamps to free spring leaves (3, 4, and 8) and permit them to separate.

ASSEMBLY OF TAPERED
THREE-LEAF SPRING

NOTE: Key numbers in text refer to figure 5.

1. Position spring leaves together in correct sequence with Delrin liners (6) inserted between leaves (3, 4, and 8).

2. Line up center bolt holes using a suitable drift tool. Position C-clamp on spring pile adjacent to center bolt holes and tighten clamp.

3. Remove drift tool, then insert center bolt (1) and install nut, tighten firmly and peen end to lock nut in place. Remove C-clamp.

4. Install spring clips (2) at each end of spring, and bend ends to complete the clip installation.

5. Position the remaining two Delrin liners (6) on top and bottom leaves over center bolt. Wind tape (5) around spring and liners at each end to hold liners in place while installing spring.

CENTER LINER REPLACEMENT
(TWO-LEAF SPRING) (Refer to Fig. 4)

After the spring U-bolts are loosened, the two leaves will generally separate to permit replacement of center liner on the locating nib of lower leaf. However, if necessary, a flat tapered pry bar can be used to separate the leaves.

CENTER LINER (DELRIN - TAPERED
THREE-LEAF SPRING ONLY)
REPLACEMENT (Fig. 5)

NOTE: If desired, liners may be removed with spring still installed on vehicle.

1. With axle safely supported, remove U-bolts. Move U-bolt spacer pad away from top of spring.

2. Raise frame to sufficient height of at least 3 inches, which is necessary to remove center bolt from spring. Safely block frame in this position.

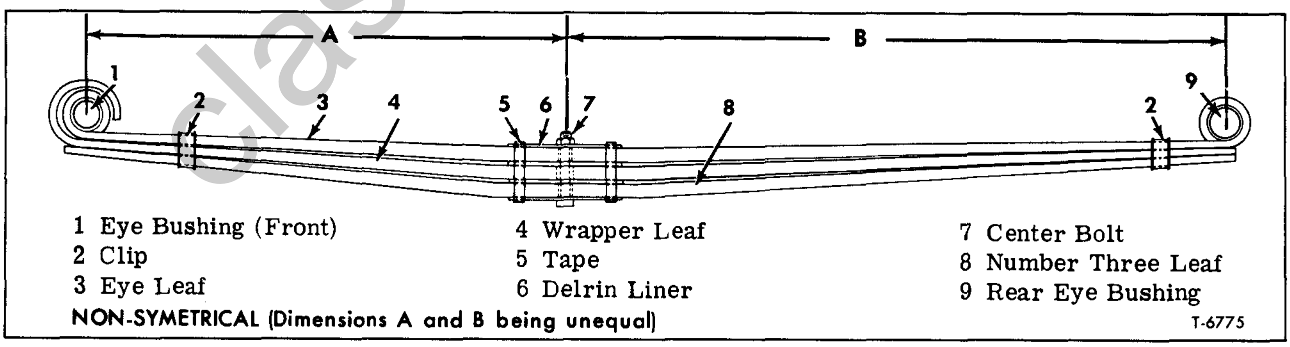


Figure 5—Tapered Leaf Front Spring Assembly (Non Symetrical Type Spring)

3. File peened end of center bolt (7) so nut can be removed. Remove nut, then drive center bolt from spring.

4. Force spring leaves apart by wedging chisel or screwdriver between leaves. Liners (6) can then be easily removed.

5. To assemble the spring to axle, the previous precedure may be reversed. Spring center bolt should be peened to prevent it from working loose. Lower frame and remove jack.

FRONT SPRING INSTALLATION (Fig. 1)

NOTE: All spring attachments, including center bolts, are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with parts of the same part numbers or with equivalent parts if replacement becomes necessary. Do not use replacement parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

All Conventional. Cab and Steel Tilt 70 Models

1. On Steel Tilt 70 Models, place rear end of spring in rear hanger, then install rebound pin, pin retainer, and pin retainer bolt.

2. On conventional cab models, raise rear end of spring to frame bracket and install shackle links and shackle pins to frame bracket and spring eye. Install shackle pin nuts.

NOTE: On some vehicles, at front with optional multi-leaf springs, position a flat washer over bolt spacer at each side of spring eye as shown in figure 2.

3. Raise front end of spring into frame forward hanger brackets.

4. Install eye bolt, eye bolt washer, and nut.

NOTE: Install caster spacer as shown in figure 6.

5. With dowel pins (when used), tow eye (when used), and caster spacer (when used) on axle pad, raise axle to spring, making sure spring center bolt or dowel pin engages hole in axle pad.

NOTE: When optional two-leaf spring is used, make sure a Delrin liner is properly located at both top and bottom of spring.

6. Install the shock absorber bracket, U-bolt spacer, U-bolts, and nuts.

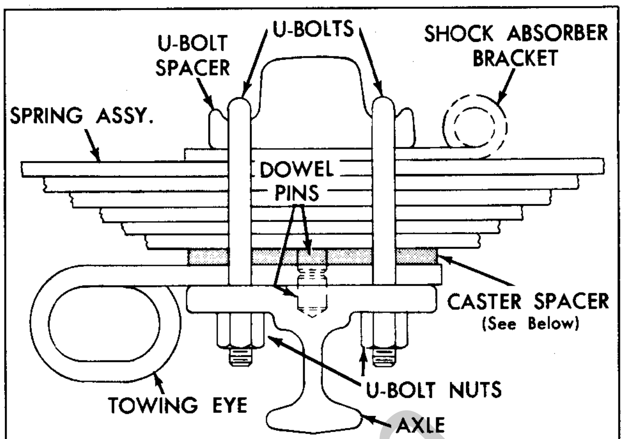


Figure 6—Front Spring Caster Shims

7. Tighten front eye bolt nut, shackle pin nuts and U-bolt nuts to torque listed in "Specifications" at end of this section.

8. Lubricate as instructed in LUBRICATION (SEC. 0) of this manual.

TAPERED THREE-LEAF SPRING INSTALLATION (ALUMINUM TILT 90 MODELS)

NOTE: Key numbers in text refer to figure 3.

1. Position spring on axle center with caster spacer (13) correctly installed between axle (16) and spring (12). THICK EDGE OF SPACER FACES TOWARD FRONT OF THE VEHICLE.

NOTE: Dowel pin is integral with caster spacer on Aluminum Tilt Models.

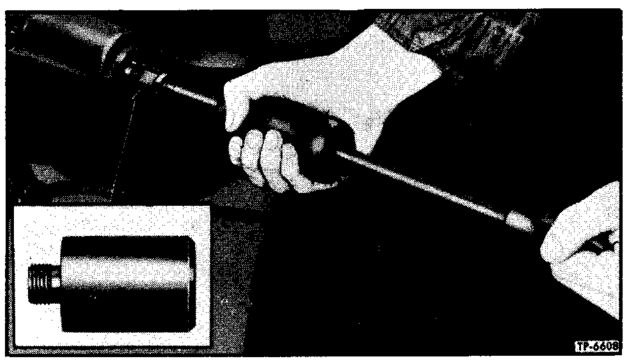


Figure 7—Removing Spring Pin or Bolt with Slide Hammer and Adapter

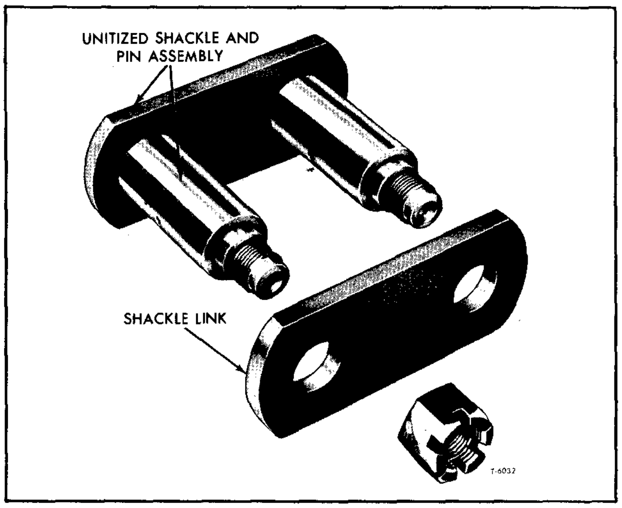


Figure 8—Unitized Shackle and Pin Assembly

2. Lower vehicle frame until spring eye (11) at front end of spring (12) aligns with hole in spring hanger (9).

3. Install spring eye pin (8) in hanger and spring eye opening, with lubrication fitting (7) facing to the outside. If clamp bolts (10) were previously removed, install bolts, nuts, and washers. Torque bolt nuts to 35-45 foot-pounds.

4. At rear of spring, insert spring shackle link assembly (6) in spring eye, and in hanger (5). Install assembly with lube fittings (7) facing toward outside. Drive link assembly in until flush with hanger and spring eye.

5. At inner side of spring and hanger, install shackle link over link assembly studs. Install nuts and torque to 110-130 foot-pounds. Install lube fittings in shackle link assembly if previously removed.

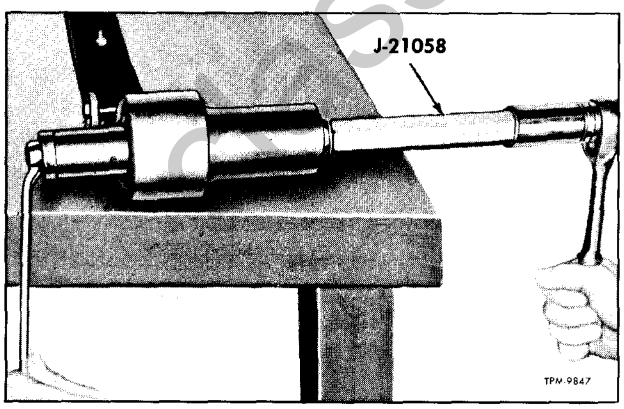


Figure 9—Removing Rubber Type Eye Bushing

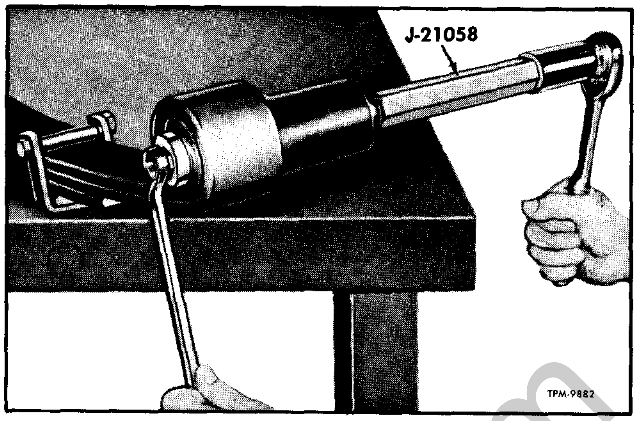


Figure 10—Installing Rubber Type Eye Bushing

6. Position U-bolt spacer block (4) on top of spring (12) and Delrin liners on tapered springs, with shock absorber bracket facing outside rear. Install U-bolts (1) over spacer and spring.

7. Install U-bolt washers and nuts (15). Tighten nuts alternately until a torque of 190 to 210 foot-pounds is obtained.

8. Install shock absorber eye and bushing to mounting on spacer bracket if previously removed. Torque nut to 70-80 foot-pounds. Lubricate spring at front and rear shackle fittings.

SHOCK ABSORBERS

Shock absorbers are non-adjustable and non-repairable. Maintenance requirements involve replacement of the rubber mounting grommets, and tightening all shock absorber pin nuts at regular intervals. If a shock absorber becomes inoperative, the complete unit must be replaced.

CAUTION: When replacing shock absorbers, check the model number stamped on the unit to make sure it is the same model as the one removed. Refer to "Specifications" for shock absorber nut torque.

IMPORTANT: U-bolts must be retightened to torque listed in "Specifications" after 500 miles when new, or after spring repair or replacement.

TORQUE SPECIFICATIONS

	FT. LBS.
FRONT SPRING U-BOLT (NUTS)	
(TM, JM, HM 80, HV, JV 70)	90-110
(MH-MI 90) (ALL 90 ALUM. TILT)	190-210
FRONT SPRING EYEBOLT (NUT)	
(HM, JM, JV, HV 70-80)	150-200
(TM-80)	300-400
(CONV. CAB 90)	150-200
FRONT BRACKET TO FRAME BOLT NUT	
(TM-80)	40-50
ALL OTHER MODELS	50-60
REAR BRACKET TO FRAME BOLT NUT	
(TM-80)	40-50
ALL OTHER MODELS	50-60
SPRING SHACKLE LINK TO REAR BRACKET AND SPRING PIN NUTS	
(HM, JM, 80), HV, JV 70)	110-130
CONV. CAB 90 (ALL 90 ALUM. TILT)	110-130
FRONT SPRING FRONT BRACKET AND STEERING GEAR BRACKET TO FRAME BOLT NUT	
(HM, JM 80, HV, JV 70)	50-60
(CONV. CAB 90)	50-60
FRONT SPRING REAR BRACKET TO LOWER SILL BOLT NUT	
(ALL)	50-60
SHOCK ABSORBER NUTS (ALL)	70-80
EYE PIN CLAMP BOLT (NUT) 90 TILT MODELS	35-45

FRONT SPRING SPECIFICATIONS

	LGT.		O.D.		I.D.	
(TILT 70-80 AND ALL CONV. CAB MODELS)	3.225″	3.250″	1.688″	1.693″	0.940″	0.947″
(ALUM. TILT 90 MODELS) TAPERED LEAF				1.653″		1.425″
(ALUM. TILT 90 MODELS) MULTI-LEAF		2.97″		1.680″		1.449″
SPRING SHACKLE BOLTS (CONVENTIONAL CAB MODELS)		5.12″	0.936″	0.937″		

DELRIN INTERLEAF LINER (THICKNESS) TAPERED LEAF SPRINGS .... 0.043″

GOOD FRONT SPRING AND SHOCK ABSORBER MAINTENANCE PAYS DIVIDENDS IN DRIVER SATISFACTION AND LESS CHASSIS REPAIR.

FRONT HUBS AND BEARINGS

DESCRIPTION

Front hubs are mounted to steering knuckle spindles on opposed tapered roller bearings as illustrated in figures 1, 2, and 3. Mounting parts, mainly bearings, soindle nuts and seals shown are of primary importance. Brake drum mounting bolts, studs and nuts, differ in type and method of installation on various series vehicles.

BEARING MAINTENANCE

All wheel bearings are adjustable for wear. Satisfactory operation and long life of bearings, depend upon proper adjustment and correct lubrication. If bearings are adjusted too tight, they will overheat and wear rapidly. Loose adjustment will cause pounding and will also contribute to steering difficulties, uneven tire wear, and inefficient brakes Bearing adjustment should be checked at regular inspection periods.

Hubs and bearings should be cleaned, inspected, and lubricated whenever hubs are removed, or at intervals indicated in LUBRICATION (SEC. 0) of this manual.

New hub oil seals should be installed when servicing bearings if there is the slightest indication of leakage, wear, or damage. An imperfect seal may permit bearing lubricant to reach brake linings, resulting in faulty brake operation and necessitating premature replacement of linings.

Servicing of oil lubricated bearings are covered later under "Oil Lubricated Front Wheel Bearings."

BEARING ADJUSTMENT

Before checking wheel bearing adjustment, make sure brakes are fully released. Jack up the front axle until tires clear floor.

Check bearing play by grasping tire at top and pulling back and forth or by using a pry bar under tire. If bearings are properly adjusted, movement of brake drum in relation to backing plate will be barely noticeable and wheel will turn freely. If movement is excessive, adjust as indicated.

FRONT WHEEL BEARINGS (OIL LUBRICATED)

New hub oil seals should be installed when there is the slightest indication of leakage, wear, or damage. An imperfect seal may permit bearing lubricant to reach brake linings, resulting in faulty brake operation and necessitating premature replacement of linings. An oil lubricated type seal is optional and required extreme care in installing as follows:

Referring to figure 4, when installing seal ring (2), apply light coat of gasket cement or sealer to inner side of ring and to spindle (1) surface.

NOTICE: Extreme care should be exercised when driving wear ring on spindle. An improvised tool of correct diameter to press evenly and directly on shoulder should be used. Drive ring on spindle while tapping tool alternately from side to side, or straight on if tool being used has a long shank which extends past end of spindle so that ring can be driven on without binding.

When ring is completely installed, edge of ring should be flush with edge of chamfer on spindle surface. Wipe any excess sealer from ring and spindle. Oil seal (3) when installed in hub (5) should be driven in until flange of seal rests against bearing (4) shoulder with lip of seal facing toward inside of hub.

NOTE: Hub cap (10) may be removed in same manner as conventional type hub caps; however, caution should be exercised to correctly install gasket (11) since oil leakage could occur at this point. Bolts (9) should be torqued evenly to 20-25 foot-pounds. Oil level should be at oil level line (fig. 5) or ¼-inch above oil level line with vehicle in a level position.. Remove 3/8-inch pipe plug to fill and wait sufficient time for lubricant to seek its level.

HUB CAP DISASSEMBLY

NOTE: Key numbers in text refer to figure 6.

1. Remove the six screws which retain window ring (5) to cap assembly (7).

2. Pry ring and window assembly (4) from cap.

3. Remove gasket (2) from cap and scrape or clean any remaining gasket from cap recess.

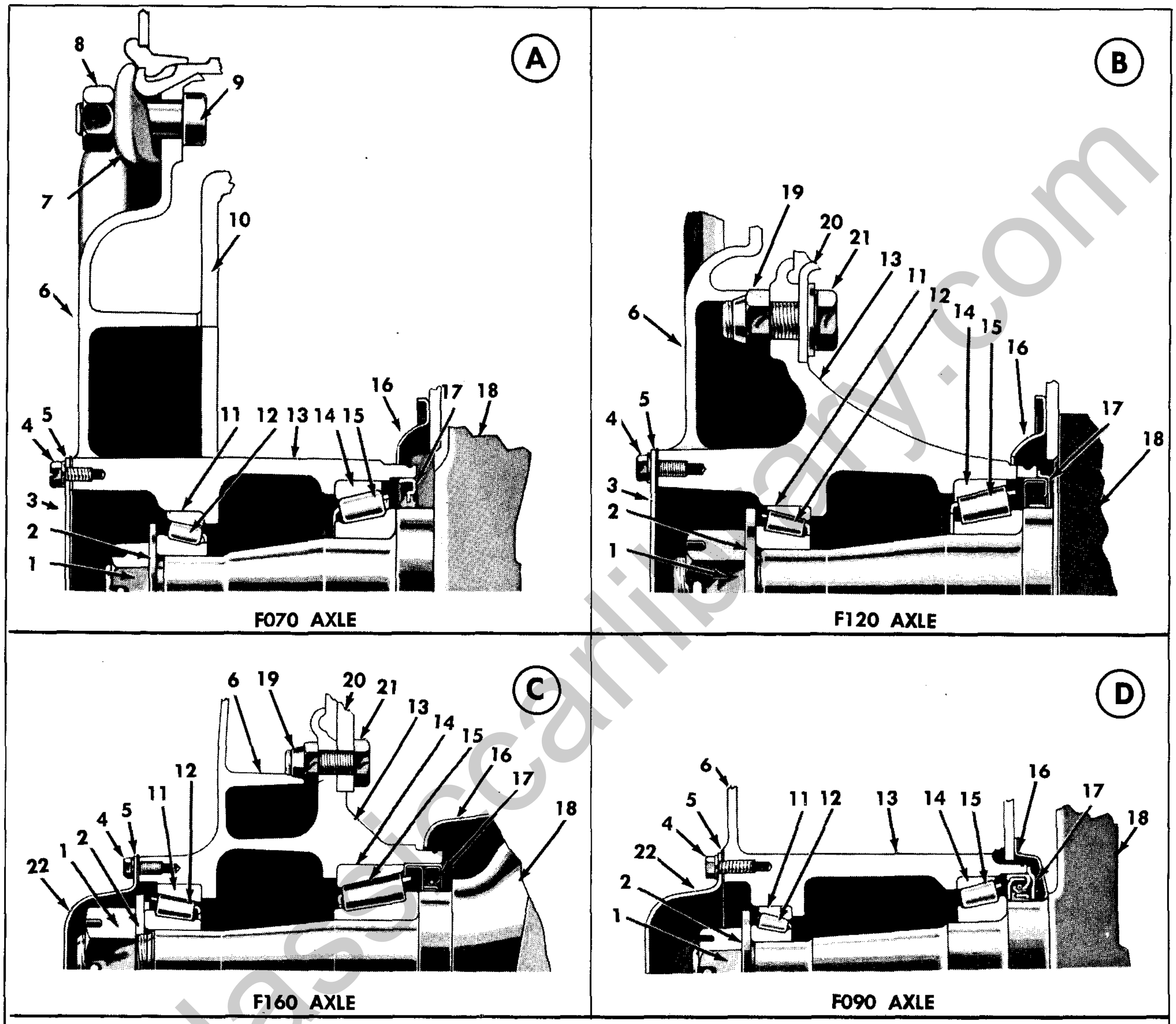
4. Window plug (3) is a flexible rubber material. Plug is press fit and may be pried from window, if desired.

ASSEMBLY

To assemble unit, reverse the above procedure using a new gasket (2).

FRONT WHEEL BEARING ADJUSTMENT

1. With wheel raised and axle safely supported, remove hub cap, or hub closure plate and gasket.
2. Remove cotter pin securing adjusting nut to spindle.
3. Back off the adjusting nut slightly, then using a torque wrench, retighten adjusting nut to 50 foot-pounds torque, at the same time turn wheel in both directions until there is a slight bind, to be sure all bearing surfaces are in contact.
4. Back off adjusting nut 1/6 to 1/4 turn, or to the nearest cotter pin hole in spindle, or sufficiently to allow the wheel to rotate freely within limits



1 Bearing Adjusting Nut
2 Adjusting Nut Washer
3 Hub Closure Plate
4 Cap Screw
5 Gasket
6 Wheel and Drum Assembly
7 Clamp
8 Wheel Nut
9 Wheel Stud
10 Brake Drum
11 Outer Bearing Cup
12 Outer Bearing Cone and Rollers
13 Hub
14 Inner Bearing Cup
15 Inner Bearing Cone and Rollers
16 Oil Shield
17 Inner Oil Seal
18 Steering Knuckle
19 Lock Nut
20 Brake Drum
21 Hub to Brake Drum Bolt
22 Hub Cap

T-6696

Figure 1—Front Hubs and Bearings (with Cast Type Wheels) (Typical)

of 0.001" to 0.007" end play.

5. Install new cotter pin. Make sure that wheel or hub turns freely.

6. Install hub cap or hub closure plate with new gasket, and tighten cap screws firmly.

7. Lower wheel to floor and remove jack.

FRONT WHEEL BEARING ADJUSTMENT (AXLE FE-900)

NOTE: Key numbers in text refer to figure 7.

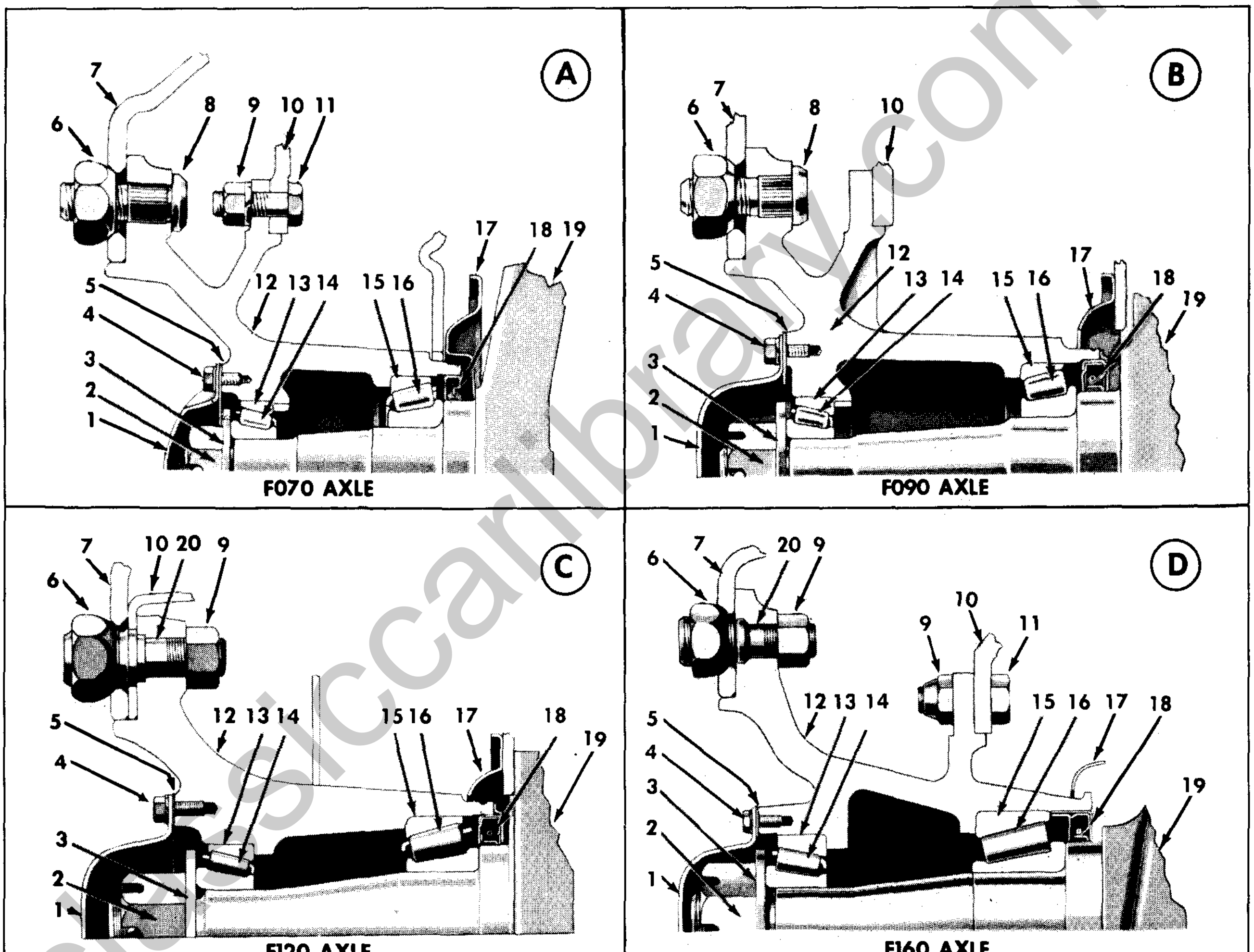
1. Remove cap screws (6) and lock washers (7) which attach hub cap (1) to hub; then remove hub cap and gasket (9).

2. Straighten nut lock (3), then remove lock nut (2), nut lock (3), and lock ring (4) from steering knuckle spindle.

3. Tighten wheel bearing adjusting nut (5) to 50 foot-pounds torque, while the hub is being rotated in both directions to correctly position the bearings.

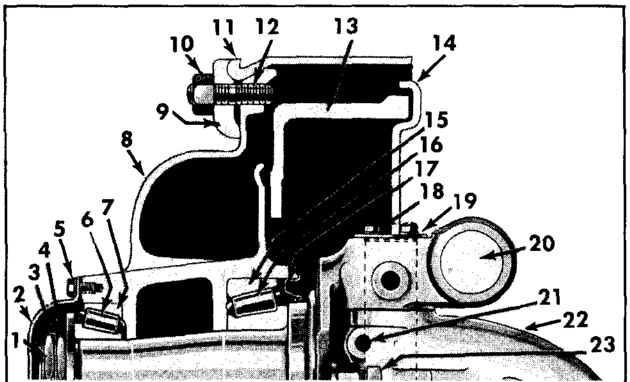
4. Back off the adjusting nut 1/4 to 1/3 turn, making sure the wheel turns freely and is within limits of 0.001" to 0.007" end play.

5. Position lock ring (4) on steering knuckle spindle with adjusting nut dowel engaging nearest hole in lock ring.



1 Hub Cap	8 Wheel Stud	15 Inner Bearing Cup
2 Bearing Adjusting Nut	9 Nut	16 Inner Bearing Cone and Rollers
3 Adjusting Nut Washer	10 Brake Drum	17 Oil Shield
4 Cap Screw	11 Hub to Brake Drum Bolt	18 Inner Oil Seal
5 Gasket	12 Hub and Drum Assembly	19 Steering Knuckle
6 Wheel Nut	13 Outer Bearing Cup	20 Wheel Stud
7 Wheel	14 Outer Bearing Cone and Rollers	T-6695

Figure 2—Front Hubs and Bearings (with Disc Type Wheels) (Typical)



1 Lock Nut	13 Brake Drum
2 Hub Cap	14 Dust Shield
3 Adjusting Nut Lock	15 Inner Wheel Bearing Cup
4 Adjusting Nut	16 Inner Wheel Bearing Cone
5 Cap Screw	17 Oil Seal
6 Outer Wheel Bearing Cone	18 King Pin Cap Screw
7 Outer Wheel Bearing Cup	19 King Pin Cap
8 Wheel Hub	20 Upper Steering Arm Opening
9 Clamp	21 Upper Draw Key
10 Wheel Nut	22 Steering Knuckle
11 Wheel Rim	23 Steering Knuckle Stop
12 Wheel Stud	

T-4487

Figure 3—Front Hub and Bearing Assembly (FE970 Axle)

NOTE: Either side of lock ring may be placed toward adjusting nut. When installing lock ring, place first one side then the other toward adjusting nut, to determine which position will permit dowel engagement with least change in position of adjusting nut (5).

6. Install nut lock (3) and lock nut (2) on steering knuckle spindle. Tighten lock nut to 200 to 300 foot-pounds torque. Bend tang of nut lock (3) over lock nut (1).

7. Attach hub cap (1) and new gasket (9) with cap screws and lock washers. Tighten screws firmly

FRONT WHEEL BEARING ADJUSTMENT (AXLE FE-970)

NOTE: Key numbers in text refer to figure 8.

1. Remove cap screws (8) and lock washers (7) which attach hub cap (1) to hub; then remove hub cap and gasket (6).
2. Raise tangs of nut lock (3), remove lock nut (2) and nut lock from steering knuckle spindle.
3. Tighten wheel bearing adjusting nut (4) to 50 foot-pounds torque while the hub is being rotated in both directions, to correctly position the bearings.
4. Back off the adjusting nut 1/4 to 1/3 turn. Check to make sure the wheel turns freely and within limits of 0.001" to 0.007" end play.
5. Install nut lock (3) and lock nut (2) on steering knuckle spindle. Tighten lock nut to 135 to 150 foot-pounds torque.
6. Bend nut lock over one flat of adjusting nut and at opposite side of washer bend flat over lock nut.
7. Attach hub cap (1) and new gasket (6) to hub with cap screws and lock washers. Tighten screws firmly.

NOTE: When these bearings are used, refer to LUBRICATION (SEC. 0) of this manual, for correct lubricant checking procedure.

FRONT HUB AND BEARING REPLACEMENT

REMOVAL (Figs. 1, 2, and 3)

1. Jack up front wheel and remove tire and rim assembly if cast wheels are used. Remove tire and wheel assembly if ventilated disc wheels are used.
2. Remove hub cap or hub closure plate and gasket.
3. Remove cotter pin or lock nut with lock, bearing adjusting nut, and adjusting nut washer.

NOTE: On vehicles equipped with front wheel speedometer, back off eccentric to provide maximum clearance between gears as outlined under "Front Axle Speedometer Drive" in "FRONT AXLE" (SEC. 3B) of this manual.

4. Pull hub and drum assembly straight off steering knuckle spindle, using care to prevent outer bearing cone and roller assembly from dropping on floor. Remove outer bearing cone and roller assembly from hub.
5. Pull inner oil seal out of hub; then remove inner bearing cone and roller assembly from hub. Discard oil seal.
6. Clean, inspect, and repair parts as necessary as directed later in this section under "Cleaning, Inspection, and Repair."

INSTALLATION (Figs. 1, 2, and 3)

1. After completing "Cleaning, Inspection, and Repair." operations described later in this section, lubricate bearings, spindle, and inside of hub as described in LUBRICATION (SEC. 0) of this manual.
2. On vehicles using felt-type oil seal, soak seal in clean oil before installing. On all other type oil seals, coat lip of seal with wheel bearing grease or equivalent before installing.
3. Place inner bearing cone and roller assembly in hub.

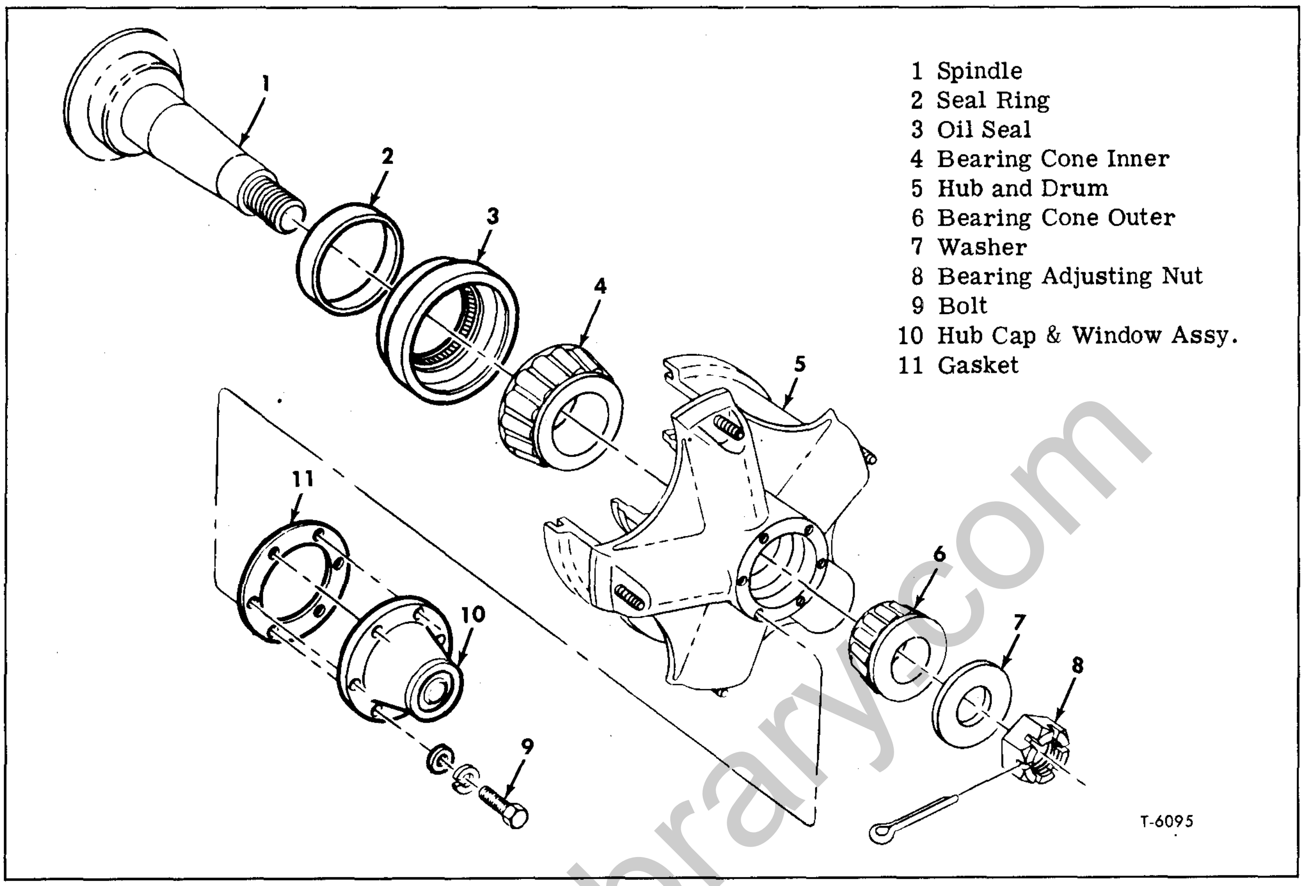


Figure 4—Oil Lubricated Type Wheel Bearing Oil Seal and Components

4. Coat oil seal bore in hub with a thin layer of non-hardening sealing compound, then press new oil seal in hub, until seal case seats against shoulder in hub or against inner bearing cup. On hubs having spring loaded lip-type seals, seal must be installed with lip pointed inward.

5. Wipe excess sealing compound out of hub. Be careful to keep compound off lip of oil seal.

6. Make sure oil deflector or shield is in place on axle spindle; then carefully install hub assembly on spindle, being careful not to damage inner oil seal.

7. Place outer bearing cone and roller assembly on spindle, pressing firmly into hub with fingers. Install adjusting nut washer and adjusting nut.

8. Install tire and rim or tire and wheel assemblies.

9. Adjust bearings and complete the installation as previously described under "Front Bearing Adjustment" previously in this section.

10. Readjust front wheel drive speedometer gear backlash as outlined under "Front Axle Speedometer Drive" in "FRONT AXLE" (SEC. 3B) of this manual.

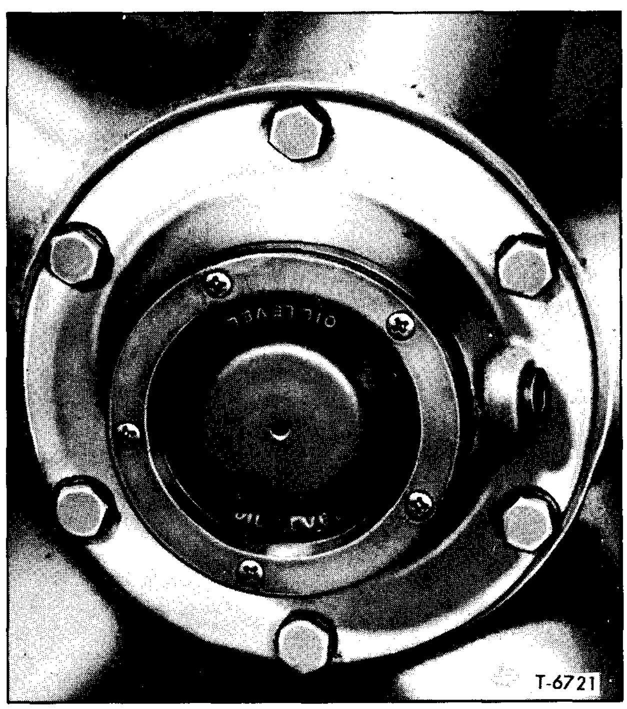


Figure 5—Oil Level (Oil Lubricated Type Bearings)

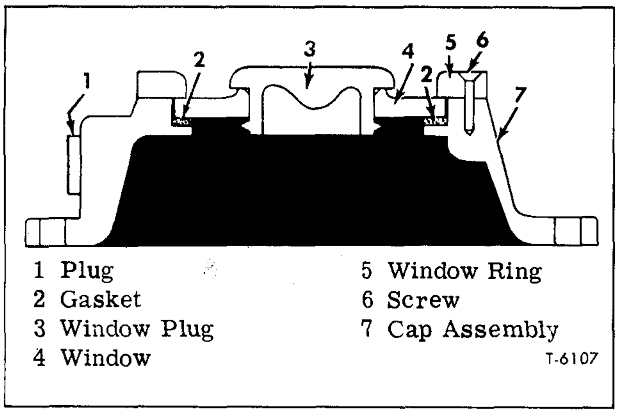


Figure 6—Oil Lubricated Type Hub Cap Components

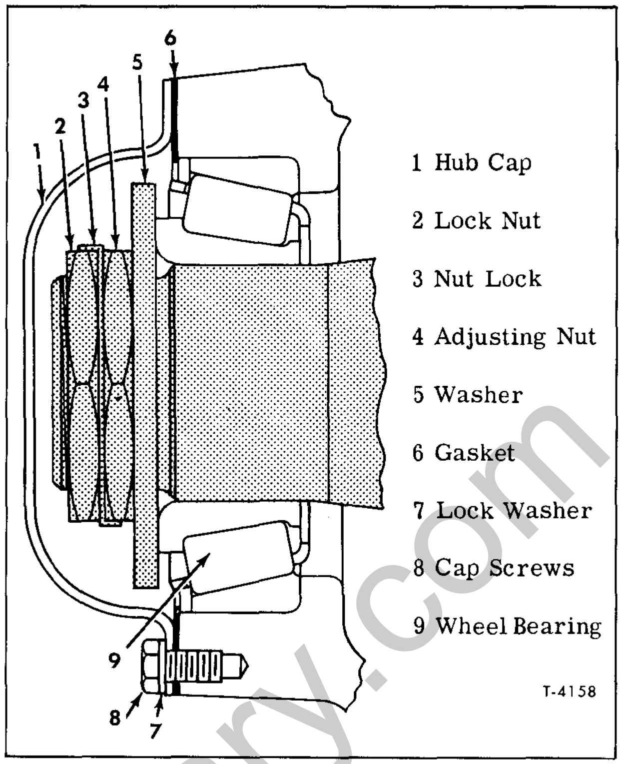


Figure 8—Front Wheel Bearing Adjustment Components (FE970 Axle)

CLEANING, INSPECTION, AND REPAIR

CLEANING

1. Immerse bearing assemblies in suitable cleaning solvent. Clean bearings with a stiff brush if necessary to remove old lubricant. Blow bearings dry with compressed air, directing air stream across bearings. Do not spin bearings while blowing them dry.
2. Thoroughly clean all lubricant out of inside of hub and wipe dry. Make sure all particles of old gasket are removed from outer end of hub, and that all sealing compound is cleaned out of oil seal bore in hub.
3. Clean lubricant off steering knuckle spindle, wash bearing adjusting nut and washer in cleaning solvent and wipe dry.

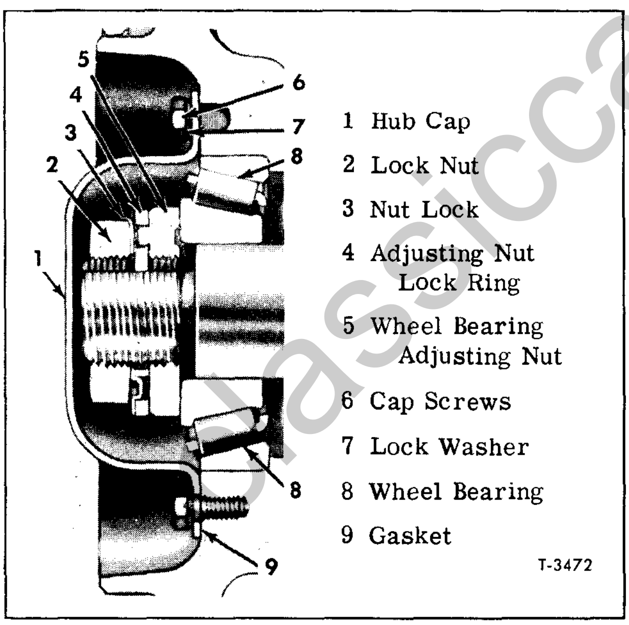


Figure 7—Front Wheel Bearing Adjustment Components (FE900 Axle)

INSPECTION

1. Inspect bearings for excessive wear, chipped edges, or other damage. Slowly roll rollers around cone to detect any flat or rough spots. If either the cone and roller assembly or the cup of the roller bearings are damaged, the complete bearing assembly must be replaced.
2. Examine bearing cups which are still installed in hub. If cups are pitted or cracked, they must be replaced as directed later under "Repair."
3. Examine brake drums for scoring or other damage. Non-demountable brake drums can be refinished while mounted on hubs (refer to "Brake Drums" in BRAKES (SEC. 5) of this manual). If necessary to replace demountable brake drum, refer to "Repair" later in this section.
4. Examine wheel bolts or studs and rim clamp studs for damaged threads and replace, if necessary, as directed later under "Repair."
5. Discard old oil seals and obtain new oil seals to be used at assembly.

REPAIR

<u>Bearing Cup Replacement</u>

1. Bearing cups are removed by using a mild steel rod through opposite end of hub and driving

against inner edge of bearing cup. Alternately drive on opposite sides of cup to avoid cocking cup and damaging inside of hub.

2. To install new cups, position cup in hub and drive into place, using a mild steel rod against outer edge of cup. Alternately drive against opposite sides to assure driving cup in squarely. Cups must seat against shoulder in hub.

Brake Drum Replacement

1. Remove bolts and lock nuts, or studs and nuts, attaching brake drum to hub.

2. Remove brake drum and oil shield or deflector (if used) from hub.

3. Apply Permatex between oil shield or deflector (if used) and brake drum.

4. Position brake drum and oil shield or deflector on hub, aligning all drain holes.

5. Install bolts and lock nuts or studs and nuts attaching brake drum to hub. Tighten securely.

Wheel Bolt Replacement

IMPORTANT: If any wheel experiences a single stud failure, caused by a loose-running wheel, all studs should be replaced. A loose-running wheel may cause only one stud to break, but more studs could be fatigued to point of failure, but not easily noticeable. Replacing only one broken stud and remounting the wheel could then promote further and possibly serious failure. If stud holes have become elongated or distorted, replace the wheel.

Wheel bolts are serrated and pressed into hub flange. To replace bolts, press bolts out of hub flange. Press new bolts into place, making sure they are a tight fit. If all bolts are removed, be sure oil shield or deflector (when used) is in place under bolt heads before installing new bolts.

Rim Clamp Stud Replacement

Rim clamp studs can be removed and replaced by using a conventional stud remover and replacer tool. When installing new studs, make sure studs are firmly bottomed in tapped holes and that threads are not damaged during installation.

Replacement of parts which show appreciable wear is more economical than a premature overhaul resulting from continued use of worn parts.

SECTION 4

REAR SUSPENSION

This group is divided into sections shown in the index below:

REAR AXLE AND CONTROLS

DESCRIPTION

Rear axles used on all vehicles covered by this publication are full floating type, using Hotchkiss, radius rod, or leaf spring drive.

Single axles are usually Hotchkiss and leaf spring drive, while tandem units are radius rod drive.

Tandem suspensions are Hendrickson equalizing beam type, Reyco, Chevrolet Air Suspension, or Page and Page, with both axles driving, however, Page and Page suspension is usually used when only one axle is driving in a tandem suspension.

Rear axles are Hypoid or spiral bevel pinion and bevel gear type. Pinion is straddle mounted between roller bearing and two adjustable tapered roller bearings. Differential is supported by adjustable tapered roller bearings mounted in differential carrier.

Housing is either banjo or bowl type, with spring seats and brackets, also brake mounting brackets welded to housing. This type construction provides exact alignment and location of axle assembly at time of assembly and installation.

Axle shafts are full-floating type. Inner end of shaft is splined and engages similar splines in differential side gear. Outer end of shaft is flanged and is attached to wheel hub by studs, tapered dowels, and nuts.

REAR AXLE CONTROLS

Paragraphs following are intended to provide information relative to several systems used to shift 2-speed and 3-speed axles. Information is also included on inter-axle differential lock controls used on the forward unit of some tandem axle units.

TWO-SPEED ELECTRIC SHIFT

The electric shift control system consists of a control switch, speedometer adapter, shift units, and interconnecting wiring harness.

CONTROL SWITCH

The control switch, mounted on transmission shift lever consists of a shift button which is positioned by the driver to operate a shift unit at axle. The driver selects the axle ratio by moving control button to select LOW and HIGH axle range (fig. 1). Movement of control button completes circuit to one field of shift unit motor when in HIGH and to opposite field when in LOW.

SHIFT UNIT

The shift unit and automatic switch assembly is mounted on the differential carrier (fig. 2). This unit, controlled by the control switch, shifts the axle into LOW or HIGH range.

When the control switch button is in HIGH range, wiring carries current to one field of the unit motor. The armature and drive screw turn in a clockwise direction and move the nut down (fig. 3).

When the nut has traveled a sufficient distance to wind the torsion spring, a contact bumper on the nut breaks an electrical connection on the automatic switch so that motor is no longer energized and the armature stops rotating. To make sure that the nut cannot travel back on the screw due to vibration, a ball screw detent spring holds the nut at the end of its travel on the screw.

The nut moves the spring winding lever down pivoting on winding and actuating lever shaft winds the torsion spring for high. Thus an increased load is put on the spring, and in this

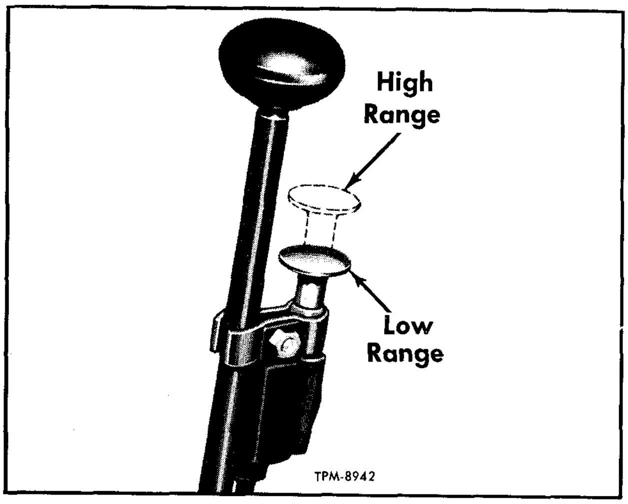


Figure 1—Two-Speed Axle Electric Shift Controls

position the axle is ready to snap into high speed ratio as soon as the load on the axle gears is relieved.

The torsion spring is assembled in the unit so that it is under approximately 50 to 90 pounds pressure, depending upon the size of the axle. When the spring winding lever is moved so that the spring is wound, the pressure of the spring is raised to approximately 90 to 140 pounds, depending upon size of axle.

The additional pressure is used to shift the axle. When the shift is completed, the ends of the spring come together leaving the original tension

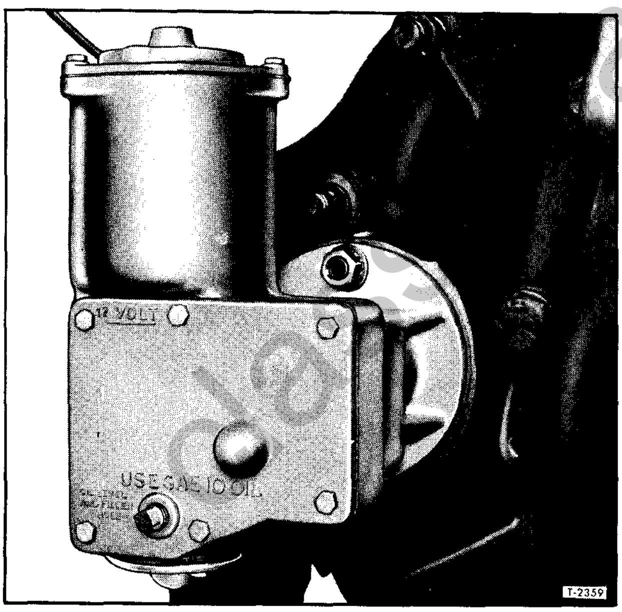


Figure 2—Two-Speed Electric Shift Unit Installed (Eaton Axle Shown)

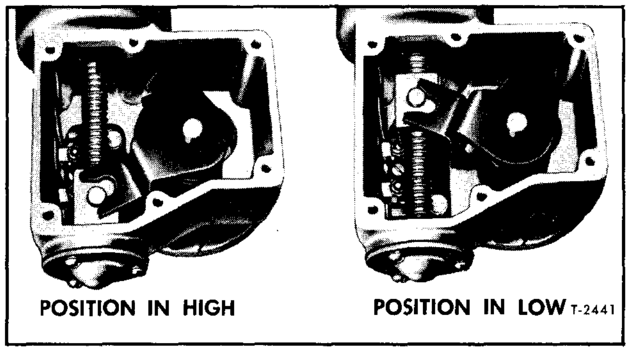


Figure 3—Position of Drive Screw in High and Low Range

on the spring. Thus pre-load tension holds the axle in either selected gear.

When the shift button is in LOW range, the motor is energized so that the motor armature and drive screw rotate to drive nut in opposite direction for shift into LOW range, in the same manner as previously described for HIGH range operation.

SPEEDOMETER ADAPTER

The speedometer adapter is mounted to back of speedometer and is electrically connected to control switch. When the control switch button is placed in LOW range, an electro-magnet shifts the adapter mechanism to compensate for the difference in gear reduction between HIGH and LOW range in the axle. When shift button is in HIGH range, current is released from the electro-magnet, and a spring holds the adapter mechanism in HIGH range position.

Speedometer adapters used on these vehicles are 12 volt type. Voltage of the unit is stamped on the housing below the wire terminal. Care should be used to select unit of same voltage as vehicle.

WIRING SYSTEM

Reference should be made to optional equipment wiring diagrams in applicable "Wiring Diagram" booklet. The ignition switch must be on before electric shift mechanism will operate.

A separate circuit breaker in the circuit protects the shift circuit in the event of a short. Refer to "Wiring Diagram" booklet for circuit breaker connections.

INTER-AXLE DIFFERENTIAL CONTROLS

A differential lock is installed as a part of forward axle to lock the inter-axle differential in the event a wheel or wheels on one of the driving axles are slipping. Lock is shifted by a power shift system, controlled by a control lever on instrument panel in cab (fig. 4).

CAUTION: USE DIFFERENTIAL LOCK ONLY WHEN NECESSARY AND NOT FOR GENERAL DRIVING.

Air operated differential lock utilizes air pressure from the air brake system for its operation. Units used in air-operated power shift system are: Control Lever, located on instrument panel in cab; Shift Control Valve, mounted on engine side of dash; Check Valve, installed in air line at control valve air inlet; Differential Lock Shift Cylinder or Chamber, mounted on forward rear axle, and interconnecting air lines and fittings.

OPERATION

When the control valve lever (fig. 4) is moved to "LOCK" position (or "Push-Pull" knob is pulled outward) the exhaust port in control valve is closed and air inlet valve is opened. Air pressure is then admitted through air lines to unit on forward rear axle.

Moving the control valve lever (fig. 4) to "UNLOCKED" position (or "Push-Pull" knob is pushed inward) closes air inlet valve and opens shift unit to pass back through air lines and exhaust to atmosphere through the control valve on dash. Shift return compression spring returns sliding clutch gear to "UNLOCKED' position.

Check valve in air supply line located behind control valve, prevents loss of air pressure in air shift axle control system if air supply pressure should drop while control valve is in "LOCK" position.

AIR SHIFT

Control of axle shifting units is accomplished by means of a two or three position control switch mounted on the transmission shift lever and is manually operated by the driver. The three-speed control switch, shown in figure 5, controls air to shift units mounted on each axle. The three-speed axle shift operating units are schematically diagramed in figure 6.

NOTE: The two-speed axle air shift controls are basically the same as for the three-speed air shift except a two position (push-pull type) shift control is used and no lock-out control valve is used on the two-speed axle shift unit.

OPERATING IN HIGH RANGE

When control switch is moved to "HI" position (fig. 5) air is permitted to pass from supply source to air shift units on each of the rear axles and axles are ready to shift into high range. When torque on axle gears is relieved by releasing the accelerator or declutching, the shift into high range is completed.

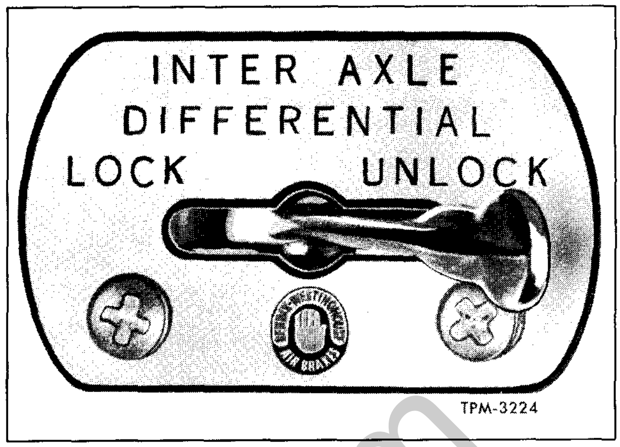


Figure 4—Inter-Axle Differential Lock Control Lever and Plate

OPERATING IN INTERMEDIATE RANGE

When the three-speed control switch is moved to "INT" position (fig. 5), air to shift unit on rearward axle is exhausted while air in forward axle shift unit is retained. Therefore, when torque on axle gears is relieved by releasing the accelerator or declutching the rearward axle is shifted into low range and forward axle remains in high range.

In intermediate range the rearward axle is operating as a double reduction unit and the forward axle as a single reduction unit. The inter-axle differential splits the torque between the

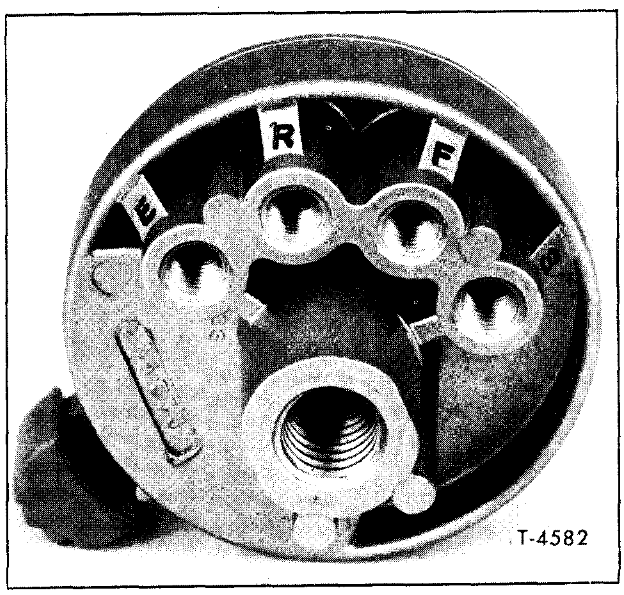


Figure 5—Three-Speed Control Switch (Air)

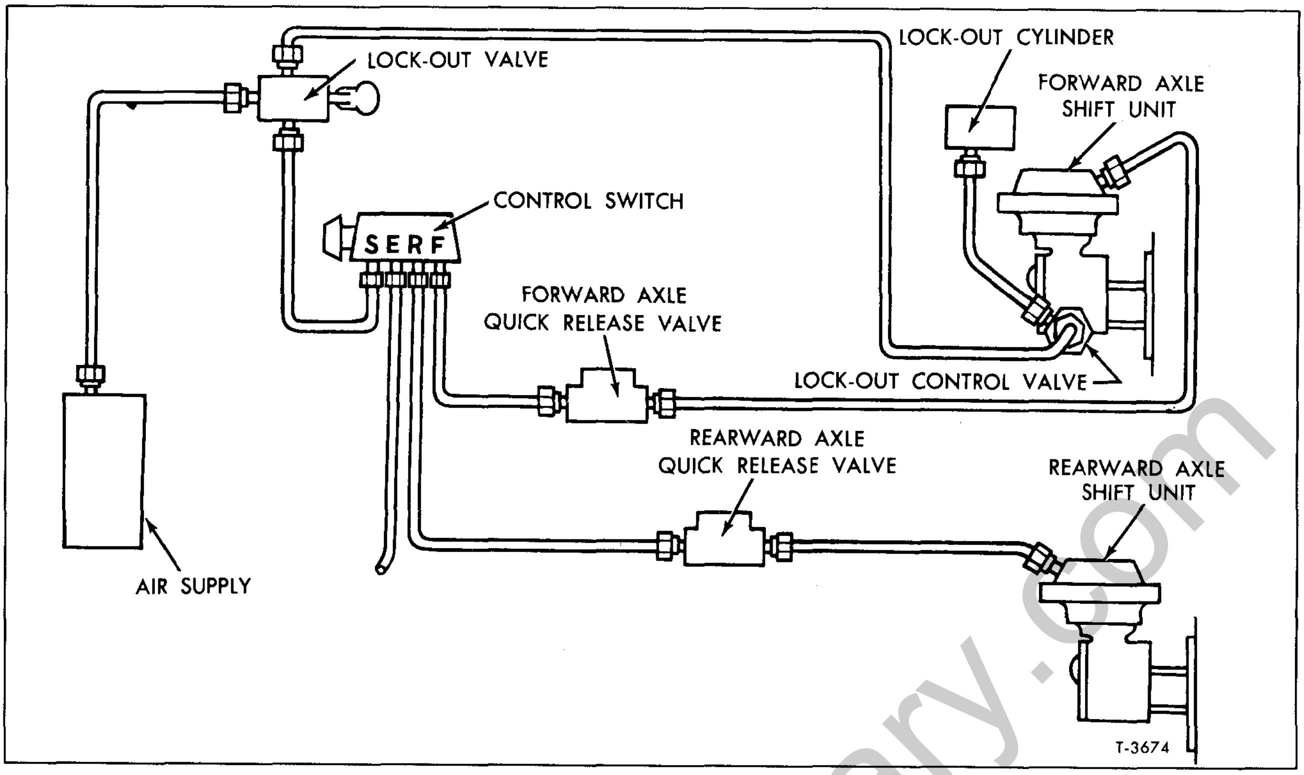


Figure 6—Schematic Diagram of Three-Speed Axle Controls (Air)

front and rear axle ratios to provide the intermediate ratio.

OPERATION IN LOW RANGE

When the control switch is moved to "LO" position (fig. 5), air is exhausted from both axle shift units and axles are ready to shift into low range. When torque on axle gears is relieved by releasing accelerator or declutching, the shift into low range is completed. In low range both axles are operating as double reduction units.

INTER-AXLE DIFFERENTIAL LOCK-OUT

The inter-axle differential lock must be used only when axles are in low ("LO") speed range. To prevent using the differential lock in "HI" or "INT" range on three-speed axle models, a switch is installed in the forward axle shift unit which prevents air pressure from reaching the lockout cylinder when axle is in high ("HI") or intermediate ("INT") speed ranges. Refer to figure 6 for schematic arrangement of air control units.

MAINTENANCE ON VEHICLE

At regular intervals, the following lubrication, inspection, and maintenance procedures should be accomplished and corrective measures taken wherever necessary.

LUBRICATION

Lubrication intervals, method of filling and draining, also type of lubricant and capacities for all axles are covered in LUBRICATION (SEC. 0).

Examine housing cover, pinion oil seal retainers, and axle shaft flanges for lubricant leaks. Tighten bolts or nuts, or replace gaskets and seals as necessary to correct leaks.

MOUNTING

Check for axle misalignment. Select a point at one side of vehicle and a corresponding point at opposite side. Measure distances between points selected and identical points at each end of axle assembly. If distances are not equal, axle misalignment is indicated and rear spring should be checked for correct installation.

Refer to REAR SPRINGS (SEC. 4B) in this manual for spring U-bolt tightening instructions.

AXLE SHAFT FLANGE MOUNTING

Axle shaft flanges are retained to hubs with stud nuts and dowels on all axles.

1. Check tightness of stud nuts at regular intervals. Tighten 1/2" nuts to 50-60 ft.-lbs. torque, or 5/8" nuts to 90-110 ft.-lbs. torque.

2. The studs must be straight and dowels of correct taper must be used. There should always be a slight clearance between nuts and driving flange when nuts are drawn up (fig. 7). No clearance at this point indicates excessive wear at studs, dowels, or holes in flange. Replacement of worn parts is the only remedy.

3. If stud nuts are not tightened to torque specified, play between flange and studs will cause bent or broken studs, also worn tapered holes in flange of axle shaft.

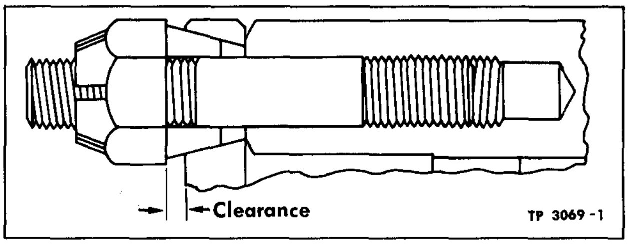


Figure 7—Clearance Between Axle Shaft Flange and Stud Nut

BENT HOUSING CHECK

A check for bent axle housing can be made with unit in vehicle in following manner; however, conventional alignment instruments can be used if available.

1. Raise rear axle with a jack until wheels clear floor. Block up axle under each spring seat.

2. Check wheel bearing adjustment and adjust if necessary, then check wheels for looseness and tighten wheel nuts if necessary. Refer to "REAR HUBS AND BEARINGS" (SEC. 4C).

3. Place a chalk mark on outer side wall of tires at bottom. Measure across tires at chalk marks with a toe-in gauge.

4. Turn wheels half-way around so that chalk marks are positioned at top of wheel. Measure across tires again. If measurement at top is 1/8" or more smaller than previous measurement noted at bottom of wheels, axle housing has sagged and is bent. If measurement at top exceeds bottom dimension by 1/8" or more, axle housing is bent at ends.

5. Turn chalk marks on both wheels so that marks are level with axle and toward rear of vehicle. Take measurement with toe-in gauge at chalk marks; then turn both chalk marks to front and level with axle and take another measurement. If measurement at front exceeds rear dimension by 1/8" or more, axle is bent to the rear. If the measurement condition is the reverse, the axle is bent forward.

ELECTRIC SHIFT MAINTENANCE AND DIAGNOSIS

The only general maintenance necessary on the shift control system is periodic lubrication of unit as described in LUBRICATION (SEC. 0). The wiring connectors should be kept tight, and wires to units should be kept in good condition.

DIAGNOSING TROUBLE

If the electric shift fails to operate properly, the system should be tested and the trouble diagnosed as described in following paragraphs. A test light consisting of a 12-volt bulb with two wires a few feet long with small battery clips on the ends. Refer to wiring diagram and test in following sequence:

1. Disconnect two wires from shift unit at rear axle. Place engine control or ignition switch in "ON" position, also place axle shift switch at shift lever in "HI" position.

2. Connect one lead of test light to ribbed wire and opposite lead to ground. One of the following conditions should exist:

a. Should light come on and stay on, the circuit is satisfactory and any trouble will probably be found in the shift unit. Repeat check for "LO" position as directed in step 3 following.

b. If the light fails to come on, this indicates that the circuit is open between the control switch and the shift unit and further tests will be required.

c. If the light comes on but cycles, this indicates that there is a short between the control or ignition switch and shift unit, and further tests will be required.

3. Remove test light lead from ribbed wire and connect to smooth wire, also place axle shift switch in "LO" position. Observe conditions as outlined in sub-paragraphs above.

4. Connect one lead of test light to control switch side of circuit breaker and opposite lead to ground. Should light come on, and stay on, the circuit is satisfactory. However, if the light fails to come on the circuit between the control switch and circuit breaker is either open or shorted.

5. Connect one test lead to load side of circuit breaker and opposite lead to ground. Should light come on, and stay on, the circuit breaker is satisfactory. However, if the light fails to come on the circuit breaker is faulty.

6. At chassis junction, remove both wires, then test circuit through red wire with white stripe. Reconnect both wires to terminal.

7. At chassis junction, remove wire from terminal. Place axle shift lever switch in "LO" position and test circuit.

8. At chassis junction, remove wire from terminal. Place axle shift lever switch in "HI" position and test circuit.

The preceding tests should readily localize

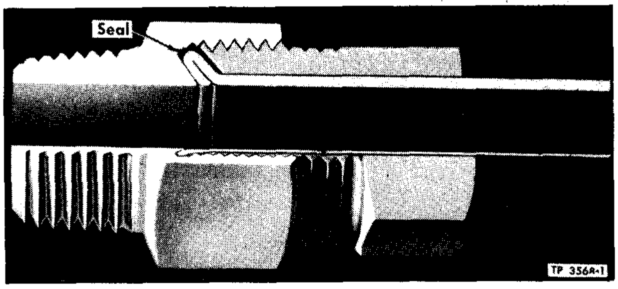


Figure 8—Tubing Connection Seal

any trouble within the system. When checking the wiring harness for shorts or open circuits, examine for broken insulation.

The control or ignition switch can be best tested by substituting a new unit.

If the vehicle shifts normally, but the speedometer adapter fails to operate, make the test to determine whether the adapter is getting current in low range. If current is present, replace the adapter. When the trouble is traced to the shift unit, it should be replaced.

AIR SHIFT UNIT

Air shift unit should be inspected and tested for proper operation and air leaks.

1. Place control switch at shift lever in "HI" position to admit air to shift unit, then apply soap suds to entire unit. Any loss of air should be corrected.
2. Move control switch through all shift positions to determine that shift unit is operating properly. Should there be any indication of a malfunction, replace or repair the shift unit.

NOTE: When testing the air shift unit, note that air pressure is present in both shift units only when control switch is in "HI", also that there is no air in either shift unit when control switch is in "LO" position. When control switch used on three-speed shift models is in "INT" position, air is present only in forward axle shift unit and air is exhausted from rearward axle shift unit.

INTER-AXLE DIFFERENTIAL CONTROL LEAKAGE TEST

AIR LEAKAGE TEST

1. Build up air pressure in air system to maximum pressure limit (100 to 105 lbs.). Place axle shift control lever in "LOCK" position.
2. Coat all air line connections with soap suds to check for leakage. No leakage in air line connections is permissible. Leakage can sometimes be corrected by tightening the connection.
3. If this fails to correct leakage, remove line having leaking connection. Slide tube nut back on tube and remove all particles of seal ring from tube and from inside of nut. Slip new seal ring over tube end. Insert tube into connector fitting and seat tube solidly in fitting (fig. 8). Slide seal ring (do not roll) into fitting. Thread tube nut into fitting and tighten slowly and firmly.
4. Coat entire surface of control valve and check valve with soap suds to check for leakage. Control valve may have some leakage past plunger. Liberally coat control lever slot in control valve body (with dial plate removed). Leakage should not exceed 1-inch soap bubble in one second. Leakage at control valve inlet and outlet connections is not permissible. If leakage is evident in any of the other units, faulty unit should be replaced.

VACUUM LEAKAGE TESTS

1. Temporarily install a "T" fitting at shift chamber and connect a vacuum gauge between chamber and vacuum line. Tighten gauge connections firmly.
2. Start engine and place differential lock control lever in "LOCK" position. Run engine long enough to obtain maximum vacuum, then stop engine and note rate of vacuum drop. If drop exceeds 1 inch in 15 seconds, leakage is excessive.
3. If leakage is indicated, coat all vacuum line connections with hydraulic brake fluid. If leak exists, fluid will be drawn into connection with engine idling and control lever in "LOCK" position.
4. Remove line having leaking connection. Slide tube nut back on tube and remove all particles of seal ring from tube and from inside of nut. Slip new seal ring over tube end. Insert tube into fitting and seat solidly. Slide seal ring (do not roll) into fitting (fig. 8). Thread tube nut into fitting and tighten slowly and firmly.
5. Repeat leakage test as directed in steps 1 and 2. If vacuum drop is still excessive, leakage is in one of the shift control units. Remove each unit and overhaul or replace as directed later under individual headings.

REFER TO NEXT PAGE FOR REAR AXLE SERVICE DIAGNOSIS

REAR AXLE SERVICE DIAGNOSIS

SYMPTOM	PROBABLE REMEDY
NOISE ON DRIVE	
Excessive Pinion to Bevel Gear Backlash	Adjust
Worn Pinion and Bevel Gear	Replace
Worn Pinion Bearings	Replace
Loose Pinion Bearings	Adjust
Excessive Pinion End Play	Adjust
Worn Differential Bearings	Replace
Loose Differential Bearings	Adjust
Excessive Bevel Gear Run-Out	Replace
Low Lubricant Level	Replenish
Wrong or Poor Grade Lubricant	Replace
Bent Axle Housing	Straighten or Replace
NOISY ON COAST	
Axle noises heard on drive will usually be heard also on coasting; although not as loud	Adjust or Replace
Pinion and bevel gear too tight (audible when decelerating and disappears when driving)	Adjust
INTERMITTENT NOISE	
Warped Bevel Gear	Replace
Loose Differential Case Bolts	Tighten

SYMPTOM	PROBABLE REMEDY
CONSTANT NOISE	
Flat Spot on Pinion or Bevel Gear Teeth	Replace
Flat Spot on Bearings	Replace
Worn Pinion Splines	Replace
Worn Axle Shaft Dowel Holes	Replace
Worn Hub Studs	Replace
Bent Axle Shaft	Replace
NOISY ON TURNS	
Worn Differential Side Gears & Pinions	Replace
Worn Differential Spider	Replace
Worn Differential Thrust Washers	Replace
Worn Axle Shaft Splines	Replace
FAILS TO SHIFT INTO HIGH OR LOW	
Defective Electrical Circuit	Correct
Defective Shift Unit	Replace
Lack of Air Pressure	Correct
Low Vacuum	Correct

MAJOR UNIT REPLACEMENT

SINGLE AXLE REPLACEMENT

REMOVAL

1. Jack up rear of vehicle until load is removed from springs, then place blocks under frame to prevent accidental dropping of vehicle.
2. Disconnect hydraulic or air brake lines, whichever is used. Refer to BRAKES (SEC. 5).
3. Disconnect electric wiring, air lines, or line from power shift unit, if vehicle is equipped with a 2- or 3-speed axle.
4. Disconnect propeller shafts as directed in "PROPELLER SHAFTS" (SEC. 4D).
5. Disconnect torque or radius rods, if used, as directed in "REAR SPRINGS" (SEC. 4B).
6. Disconnect spring U-bolts as directed in "REAR SPRINGS" (SEC. 4B).
7. Roll axle out from under vehicle, then remove wheels, hubs, and bearings as directed in "REAR HUBS AND BEARINGS" (SEC. 4C).
8. Whenever another axle is to be installed instead of the one removed, it may be necessary to remove two speed shift unit, and brake chambers. Refer to respective sub-sections for instructions.

INSTALLATION

1. If brake chambers or two-speed shift unit have been removed, they should be reinstalled as directed in respective sections.
2. Install hubs, wheels and tires as directed in "REAR HUBS AND BEARINGS" (SEC. 4C). Roll axle into position under vehicle.
3. Connect springs to axle as directed in "REAR SPRINGS" (SEC. 4B).
4. Reconnect torque rods as directed in "REAR SPRINGS" (SEC. 4B). On some vehicles torque rods are adjustable to secure proper axle alignment.
5. Reconnect propeller shafts as directed in "PROPELLER SHAFTS" (SEC. 4D).
6. Reconnect electric wiring, air lines or line at power shift unit, if vehicle is equipped with a 2- or 3-speed axle.
7. Reconnect brake lines as directed in BRAKES (SEC. 5).
8. Check lubricant level and fill with type and grade of lubricant in manner instructed in LUBRICATION (SEC. 0). Some types of axles require additional lubricant at pinion cage when filled initially or after overhaul.

9. Remove blocks and lower vehicle to the ground. Retighten spring U-bolts as instructed in "REAR SPRINGS" (SEC. 4B).

10. After all installation procedures have been completed, check air lines for leaks, also test brakes for proper application.

TANDEM AXLE REPLACEMENT

REMOVAL

1. Jack up rear of vehicle until load is removed from springs, then place blocks under frame to prevent accidental dropping of vehicle.
2. Disconnect air brake lines at brake chambers. Refer to BRAKES (SEC. 5).
3. Disconnect wiring or air line from power shift unit, if equipped with a 2- or 3-speed axle.
4. Disconnect air line from inter-axle differential lock shift cylinder.
5. Disconnect propeller shafts as directed in "PROPELLER SHAFTS" (SEC. 4D).
6. On Hendrickson type suspension, disconnect axle housing from equalizing beam as directed in "REAR SPRINGS" (SEC. 4B).
7. On Page and Page type suspension disconnect axle housing from spring as directed in "REAR SPRINGS" (SEC. 4B).
8. On Chevrolet air suspension disconnect axle housing as directed in "REAR SPRINGS" (SEC. 4B).
9. Disconnect torque or radius rods as directed in "REAR SPRINGS" (SEC. 4B).
10. Roll axle out from under vehicle, then remove wheels, hubs, and bearings as directed in "REAR HUBS AND BEARINGS" (SEC. 4C).
11. Whenever another axle is to be installed, it may be necessary to remove the two- or three-speed shift unit and brake chambers.

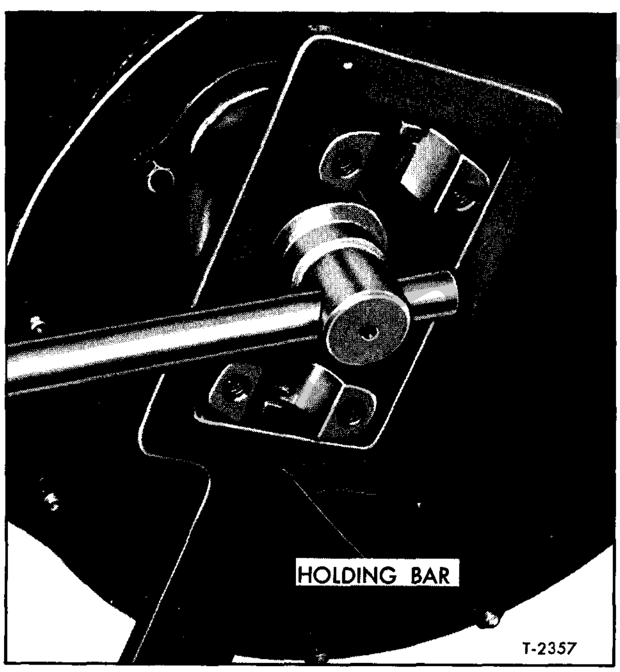


Figure 9—Propeller Shaft Yoke Holding Bar

INSTALLATION

1. If brake chambers or axle shift units have been removed, they should be reinstalled as directed in respective sections.
2. Install hubs, wheels and tires as directed in "REAR HUBS AND BEARINGS" (SEC. 4C). Roll axle into position under vehicle.
3. On Hendrickson type suspension connect axle to equalizing beam as directed in "REAR SPRINGS" (SEC. 4B).
4. On Page and Page type suspension connect axle housing to spring as directed in "REAR SPRINGS" (SEC. 4B).
5. On Chevrolet air suspension, connect axle housing to lower torque arm as directed in "REAR SPRINGS" (SEC. 4B).
6. Reconnect torque rods as directed in "REAR SPRINGS" (SEC. 4B). On some vehicles torque rods are adjustable to secure proper axle alignment.
7. Reconnect propeller shafts as directed in "PROPELLER SHAFTS" (SEC. 4D).
8. Reconnect electric wiring or air line at power shift unit, if vehicle is equipped with a 2- or 3-speed axle.
9. Connect air line at inter-axle differential lock shift cylinder.
10. Reconnect air brake lines as directed in BRAKES (SEC. 5) in this manual.
11. Check lubricant level and fill with type and grade of lubricant in manner instructed in LUBRICATION (SEC. 0) in this manual. Some types of axles require additional lubricant at pinion cage and inter-axle differential shift housing, when filled initially or after overhaul.
12. Remove blocks and lower vehicle to the ground. Retighten spring U-bolts or torque arm lower plate bolts as instructed in "REAR SPRINGS" (SEC. 4B).
13. After all installation procedures have been completed, check all air lines for leaks, also test brakes for proper application.

DIFFERENTIAL CARRIER REPLACEMENT

It may be desirable to remove the carrier assembly from the axle housing, while the housing remains installed under the vehicle.

To assist in handling the differential carrier assembly, a roller jack should be available; also, a pan for draining lubricant.

Inspect axle housing for lubricant leaks before cleaning, then steam clean thoroughly to remove all dirt or other foreign matter.

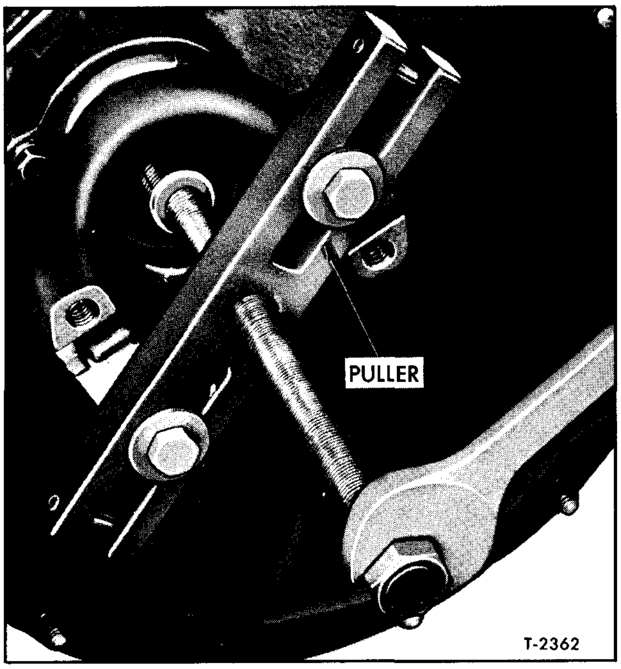


Figure 10—Propeller Shaft Yoke Puller (Typical)

REMOVAL

All Axles

1. Remove plug at bottom of housing to drain lubricant.

2. Remove axle shafts as directed under heading "Axle Shaft Replacement" in this section.

3. On 2- or 3-speed axles disconnect wiring or air lines from shift unit, also remove air line from inter-axle differential lock shift cylinder on forward axle of tandem units.

4. Disconnect propeller shaft from yoke as directed in "PROPELLER SHAFTS" (SEC. 4D).

Additional steps are required on different axles as indicated under applicable headings following:

Single Axle or Rearward Tandem Unit

1. Remove cap screws or stud nuts, and lock washers, except two near top. Loosen two at top and leave installed to prevent carrier falling.

2. Support carrier on roller jack, remove top stud nuts or cap screws, then work carrier free of housing. A small pinch bar may be used to keep carrier straight in housing bore, while carrier is withdrawn. End of bar must be rounded to prevent damage to carrier flange.

Eaton Tandem Forward Unit

1. Remove yoke nut while holding yoke with J-3453 (fig. 9) and washer, then remove yoke using suitable puller (fig. 10). Remove bearing retaining washer.

2. Remove stud nuts, cap screw, and lock washers attaching cover to rear of axle housing. Remove cover assembly with oil seal and bearing (fig. 11).

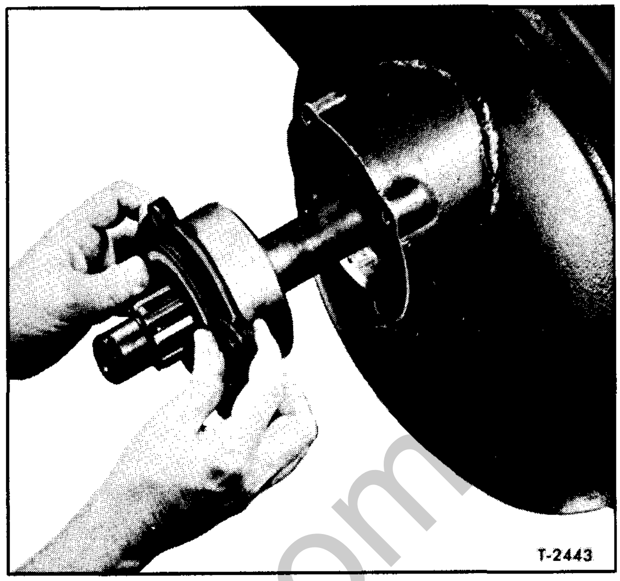


Figure 11—Removal or Installation of Thru-Shaft Rear Bearing, and Retainer

3. At front of housing, remove differential carrier to axle housing cap screw, stud nuts, and lock washers, except two near top. Loosen two at top and leave installed to prevent carrier falling.

4. Support carrier on roller jack, remove top stud nuts and lock washers, then work carrier free of housing. A small pinch bar may be used to keep carrier straight in housing bore, while carrier is withdrawn. End of bar must be rounded to prevent damage to carrier flange.

Rockwell Tandem Forward Unit

1. At right side of differential carrier adapter case, remove inter-axle differential lock shift housing cap screws and lock washers, then remove housing and shift cylinder assembly (fig. 12).

2. At thru-shaft rear bearing and oil seal retainer, remove cap screws and lock washers.

3. Tap retainer lightly with soft hammer to loosen retainer from housing bowl.

4. As thru-shaft and retainer assembly is being pulled rearward, grasp the sliding clutch gear through shift housing opening and remove gear from shaft.

INSTALLATION

Single Axle or Rearward Tandem Unit

1. Install new differential carrier to housing gasket over studs or align bolt holes in gasket with holes in housing. On axles using cap screws,

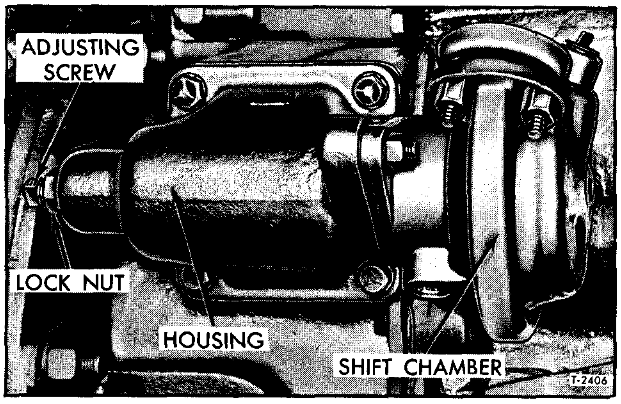


Figure 12—Inter-Axle Shift Chamber and Housing Installed (Rockwell)

install four temporary studs which will simplify locating carrier and gasket and assist in drawing carrier into place.

2. Roll carrier into place using roller jack. Start carrier over studs and into housing, using flat washers under four equally spaced stud nuts.

3. Tighten all nuts evenly and alternately until carrier is in position. Replace temporary flat washers. Install lock washers, then tighten all nuts to specified torque.

4. Perform additional installation operations as directed later under heading "All Axles."

Eaton Tandem Forward Unit

1. Install new carrier to housing gasket.

2. Roll carrier assembly into position using roller jack. Start carrier over studs and dowel pin, using flat washers under four stud nuts.

3. Tighten all stud nuts evenly and alternately until carrier is in position. Replace temporary flat washers. Install lock washers, then tighten all nuts to specified torque.

4. At rear of housing, install new cover to housing gasket over studs in housing.

5. Position cover assembly, with bearing and oil seal, over studs and output shaft.

6. Install lock washers, cap screw, and stud nuts. Tighten to recommended torque.

7. Apply rear axle lubricant to rear bearing and lip of oil seal.

8. Install bearing retaining washer, propeller shaft yoke, retaining washer, and nut. Tighten nut to recommended torque, using holding bar and socket wrench in manner illustrated in figure 9.

9. Perform additional installation operations as directed later under heading "All Axles."

Rockwell Tandem Forward Unit

1. Install new carrier to housing gasket.

2. Roll carrier assembly into position using roller jack. Start carrier over studs in housing, using flat washers under equally spaced stud nuts.

3. Tighten all nuts evenly and alternately until carrier is in position. Replace temporary flat washers. Install lock washers, then tighten all nuts to specified torque.

4. Install new thru shaft bearing retainer to rear of axle housing bowl.

5. Install thru shaft into housing (fig. 11). As shaft is pushed forward, slide clutch gear over forward end of shaft.

6. Rotate and push shaft forward until rear bearing is against housing. Install retaining cap screws with lock washers and tighten to recommended torque.

7. Install inter-axle shift housing to carrier gasket.

8. Position shift housing to carrier (fig. 12) with shift lever in shift collar groove.

9. Install and tighten cap screws and lock washers to recommended torque.

10. Perform additional installation operations as directed later under heading "All Axles."

All Axles

1. Connect propeller shaft to rear axle yoke as directed in "PROPELLER SHAFTS" (SEC. 4D).

2. On 2- or 3-speed axles connect wiring to electric shift unit or air lines to shift units, also connect air line to inter-axle differential lock shift cylinder on forward axle of tandem units.

3. Install axle shafts as directed under heading "Axle Shaft Replacement" in this section.

4. Fill to level of filler plug opening with lubricant recommended in LUBRICATION (SEC. 0) of this manual.

COMPONENT REPLACEMENT

At inspection intervals it may be advisable to replace certain items which are accessible without necessitating removal of the axle.

AXLE SHAFT REPLACEMENT

REMOVAL

Procedure for removal of axle shafts is the same with axle assembly removed or installed.

1. Remove nuts from studs attaching axle shaft flange to wheel hub.

2. Strike center of flange with a lead hammer to loosen flange and split tapered dowels.

3. Remove split tapered dowels from studs. In some instances it may be necessary to spread dowels, while being removed.

4. Grasp axle shaft flange and pull outward to remove. Remove and discard gasket.

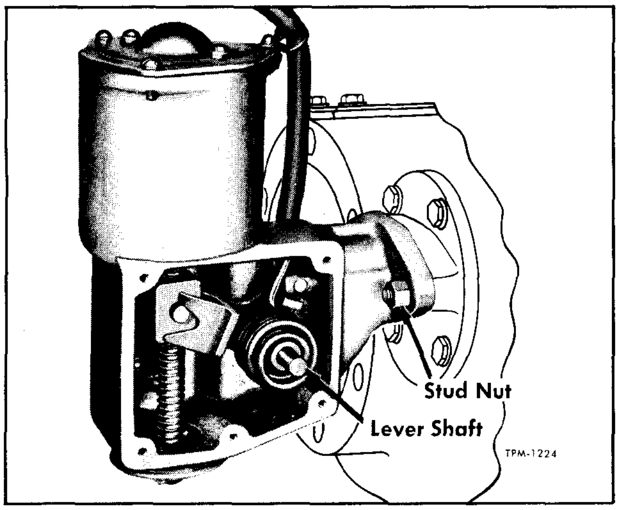


Figure 13—Shift Unit Cover Removed (Rockwell)

INSTALLATION

1. Install new gasket over hub studs and against hub.
2. Dip splined end of shaft in axle lubricant, and insert shaft through hub.
3. Turn shaft as necessary to index shaft splines with differential side gear splines.
4. As shaft is pushed inward, rotate as necessary to align flange holes with hub studs, then press shaft inward until flange is against hub.
5. Install split tapered dowel over each stud. Install and tighten 5/8" nuts to 90-110 ft.-lbs. torque or 1/2" nuts to 50-60 ft.-lbs. torque.
6. Observe that clearance exists between nut and flange (fig. 7). If no clearance exists, this indicates excessive wear at studs, dowels, or flange holes. Replace worn parts if necessary.

TWO- OR THREE-SPEED SHIFT UNIT REPLACEMENT

REMOVAL

1. On electric shift units remove lock nuts attaching two wires, then after noting wire to terminal position, remove the wires. On air shift units, disconnect air lines from axle shift unit.

NOTE: It is necessary to partially disassemble the Rockwell electric 2-speed unit to remove it from axle housing. Accomplish in following manner:

2. Remove five screws from shift unit housing cover, then remove cover. This also drains the lubricant. After cover is removed, note that drive screw nut is either at top or bottom (fig. 13) depending on whether axle is in "HIGH" or "LOW" range position.
3. Loosen shift unit-to-differential carrier stud nuts (fig. 13) to remove preload from shift unit spring.

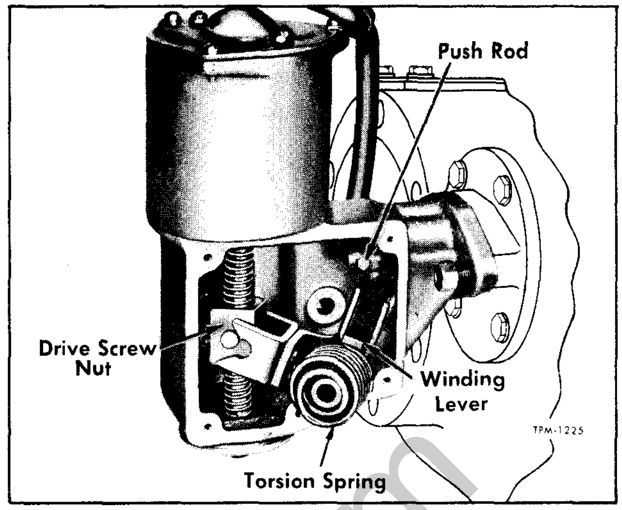


Figure 14—Torsion Spring Removal (Rockwell)

4. Turn drive screw by hand to run nut to mid-way position on drive screw as shown in figure 14. This is necessary to prevent damage to drive nut contact bumper.
5. Pull out lever shaft (fig. 13). Disconnect torsion spring from push rod, then remove spring and spring winding lever (fig. 14).
6. Remove shift unit-to-differential housing stud nuts, then remove shift unit from axle.

INSTALLATION

1. Check condition of rubber seal between shift unit and carrier. Seal must be in good condition to prevent axle lubricant entering shift unit.

NOTE: Seal bears lettering "BOTTOM - FORWARD TANDEM" and "BOTTOM - SINGLE AND REAR TANDEM," as indicated in figure 15. Be sure seal is properly positioned at installation.

2. On all units except Rockwell electric two-

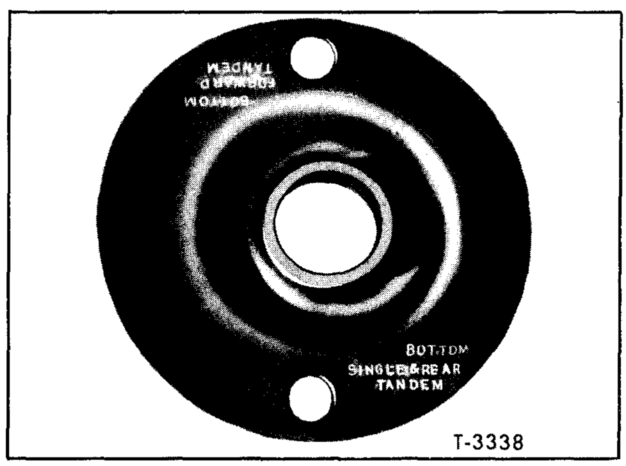


Figure 15—Shift Unit Seal Markings

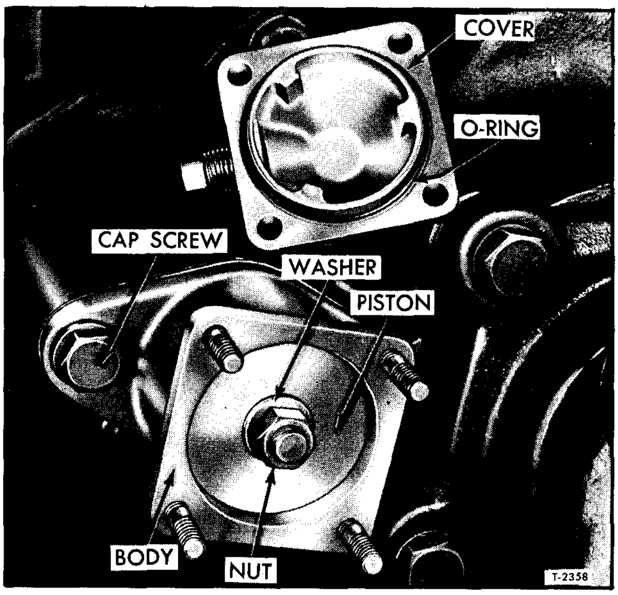


Figure 16—Inter-Axle Air Shift Chamber Components (Eaton)

speed, position the shift unit on the attaching studs, install nuts and washers and tighten firmly.

3. Connect wires to proper terminal as previously noted or connect air line.

4. On Rockwell electric two-speed, position shift unit on attaching studs and start attaching nuts. Turn drive screw by hand to run drive nut to mid-way position on drive screw as shown in figure 14, connect torsion spring to push rod (fig. 13) and insert lever shaft (fig. 13) and winding lever.

5. Position cover onto housing, noting that lever shaft is inserted in hole in cover, install five screws attaching cover to housing.

6. Lubricate shift unit as outlined in LUBRICATION (SEC. 0) in this manual.

7. Check operation of unit.

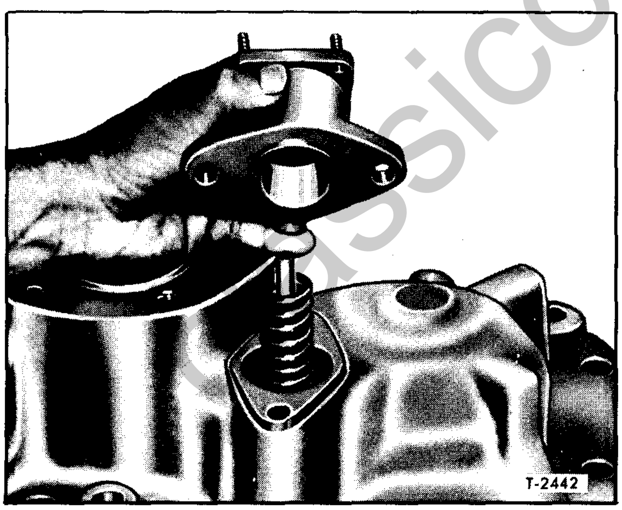


Figure 17—Inter-Axle Air Shift Chamber and Spring (Eaton)

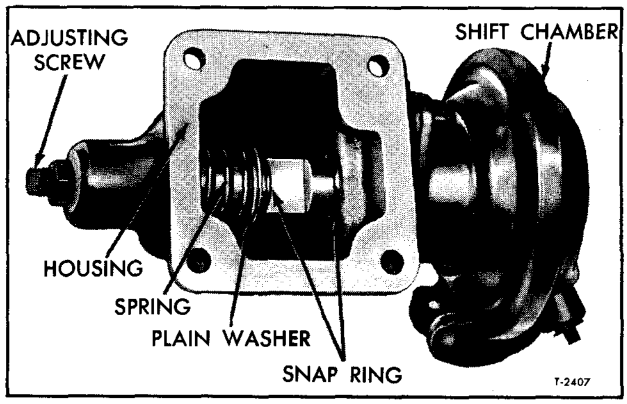


Figure 18—Inter-Axle Air Shift Chamber and Housing (Rockwell)

PINION OIL SEAL REPLACEMENT

Several types of oil seal installations are used on axles covered by this publication. One type has the seal assembly installed directly into differential carrier, while another has the seal installed in a retainer which is then attached to carrier by cap screws.

REMOVAL

1. Remove propeller shaft from yoke at axle as directed in "PROPELLER SHAFTS" (SEC. 4D).

2. Hold propeller shaft yoke with holding bar (fig. 9) while removing yoke retaining nut and washer.

3. Use suitable puller in manner typically illustrated in figure 10 to remove propeller shaft yoke.

4. On axle where seal and retainer is pressed into carrier, use available removing tool such as punch or pry bar. Remove flat washer from counterbore in carrier.

5. On axles where seal and retainer assembly are attached to carrier by cap screws, remove screws and washers, then lift assembly from carrier.

NOTE: Some axles also have a cork seal installed in a groove in pinion cage, which should be replaced.

INSTALLATION

1. Before installing new seal, be sure that differential carrier is cleaned of all deposits, such as oil, dirt, etc.

2. On axles where seal and retainer is pressed into carrier, install flat washer in carrier, then install strip sealer around carrier counterbore and against washer.

3. Coat outer surface of seal retainer with sealing compound, then position assembly in carrier. Use suitable tool to press or drive retainer into carrier until seated against flat washer.

4. On axles where seal and retainer assembly is attached to carrier by cap screws, install cork seal in groove or gasket on pinion cage.

NOTE: Be sure that gasket does not cover any oil passage holes in pinion cage.

5. Install oil seal and retainer assembly over pinion and against pinion cage. Secure with cap screws and lock washers, tightened alternately and evenly.

6. Coat lip of oil seal with axle lubricant, then install propeller shaft yoke, washer, and nut. Hold yoke with holding bar (fig. 9) while tightening nut to recommended torque.

INTER-AXLE SHIFT UNIT REPLACEMENT

The following information covers replacement of inter-axle shift units as used on Eaton and Rockwell tandem axles.

REMOVAL - EATON (AIR)

1. Disconnect air line from shift cylinder cover.
2. Remove four stud nuts and lock washers attaching cover to inter-axle differential shift cylinder. Remove cover and ring seal (fig. 16).
3. Remove nut, washer, and ring seal (fig. 16) attaching piston to shift fork shaft.
4. Remove two cap screws and lock washers attaching cylinder to differential carrier cover. Remove cylinder and piston assembly (fig. 17). Remove spring from fork shaft.

INSTALLATION - EATON (AIR)

1. Position new gasket on differential carrier cover, also install spring over shift fork shaft (fig. 17).
2. Position shift cylinder and piston assembly over shift fork shaft.
3. Install ring seal over shift fork shaft and into piston counterbore. Install washer and nut, then tighten nut (fig. 16).
4. Install new seal ring onto cover (fig. 16), then install cover on cylinder. Install four lock washers and stud nuts.
5. Reconnect air line and check for leaks and proper shifting operation.

REMOVAL - ROCKWELL (AIR)

1. Disconnect air line from shift chamber.
2. Remove four cap screws and lock washers attaching inter-axle shift chamber housing to differential carrier. Pull housing and chamber assembly from carrier.
3. Using pliers, remove two snap rings from shift chamber shaft (fig. 18).

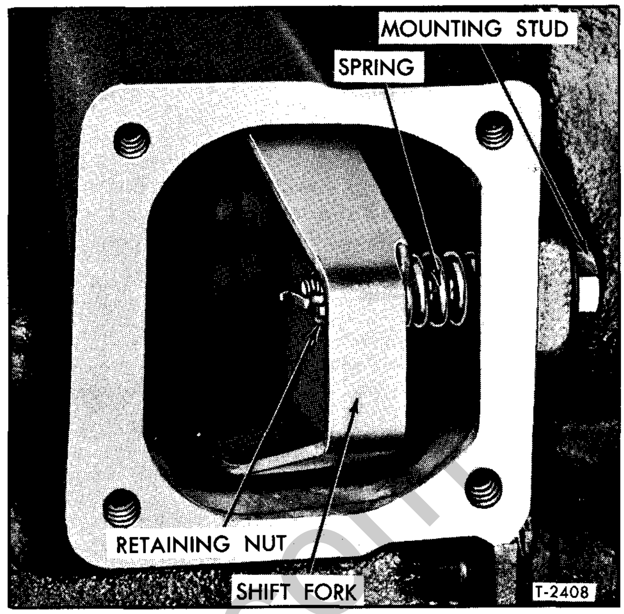
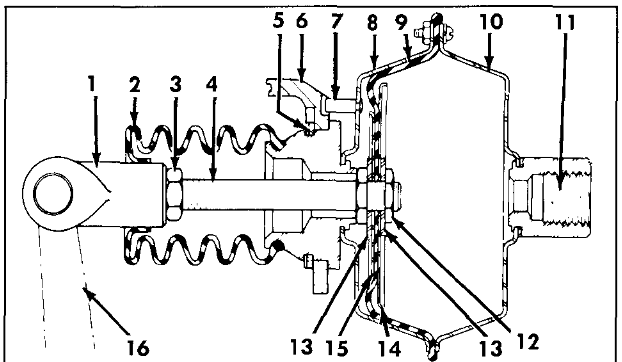


Figure 19—Inter-Axle Shift Fork Installed (Rockwell)

4. Remove two nuts from studs attaching shift chamber to housing. Remove flat washer and spring from shift chamber shaft while chamber assembly is pulled from housing.

NOTE: While shift chamber is removed inspect shift fork in differential carrier. If necessary, remove as follows:

5. At side of carrier, through shift housing opening, remove cotter pin, nut, button, shift yoke,



1 Adjustable Yoke	11 Vacuum Inlet
2 Boot	12 Diaphragm Nut
3 Lock Nut	13 Plate Washer
4 Diaphragm Rod	14 Diaphragm Plate (Large)
5 Snap Ring	15 Diaphragm Plate (Small)
6 Mounting Bracket	16 Shift Lever
7 Locating Dowel	
8 Chamber Half (Inner)	
9 Diaphragm	
10 Chamber Half (Outer)	

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Figure 20—Inter-Axle Vacuum Shift Chamber (Eaton)

cap, and spring (fig. 19). Stud is pressed into housing and it may be necessary to press out slightly in order to remove shift yoke.

INSTALLATION - ROCKWELL (AIR)

1. Through opening in differential carrier, install following on shift yoke bolt in order named: spring, cup, yoke, button, and nut (fig. 19).

2. During above installation procedure shift yoke must be in groove of sliding clutch. Press stud into housing, tighten nut, and install cotter pin.

3. Position shift chamber in shift housing with flat washer and spring over chamber shaft. Shift fork slot in chamber shaft must be toward opening in housing.

4. Install snap rings in each of two grooves in shift chamber shaft. Install stud nuts attaching shift chamber to shift housing.

5. Position shift housing and chamber assembly to differential carrier (fig. 12) with shift yoke in slot of shift chamber shaft. Install cap screws and lock washers, then tighten to recommended torque.

1 Motor Cover to Housing Screw (with Washer)
2 Motor to Cover Nut
3 Motor Cover Cable Clip
4 Motor Cover
5 Motor Cover Gasket
6 Electric Motor
7 Motor Grommet
8 Shift Unit Housing
9 Switch Terminal Nut (outside)
10 Switch Terminal Washer (outside)
11 Switch Terminal Bushing
12 Bearing (with snap ring)
13 Bearing Lock Nut
14 Bearing Cover Gasket
15 Bearing Cover
16 Bearing Cover to Housing Screw (With Washer)
17 Automatic Switch Assembly
18 Switch to Housing Screw (inside)
19 Switch Terminal Nut (inside)
20 Drive Screw Assembly
21 Winding and Actuating Lever Shaft
22 Shift Fork Actuating Lever Assembly
23 Torsion Spring
24 Spring Winding Lever Assembly
25 Shift Housing Cover Gasket
26 Shift Housing Cover and Detent Spring
27 Lubricant Plug
28 Housing Cover to Housing Screw (with Washer)

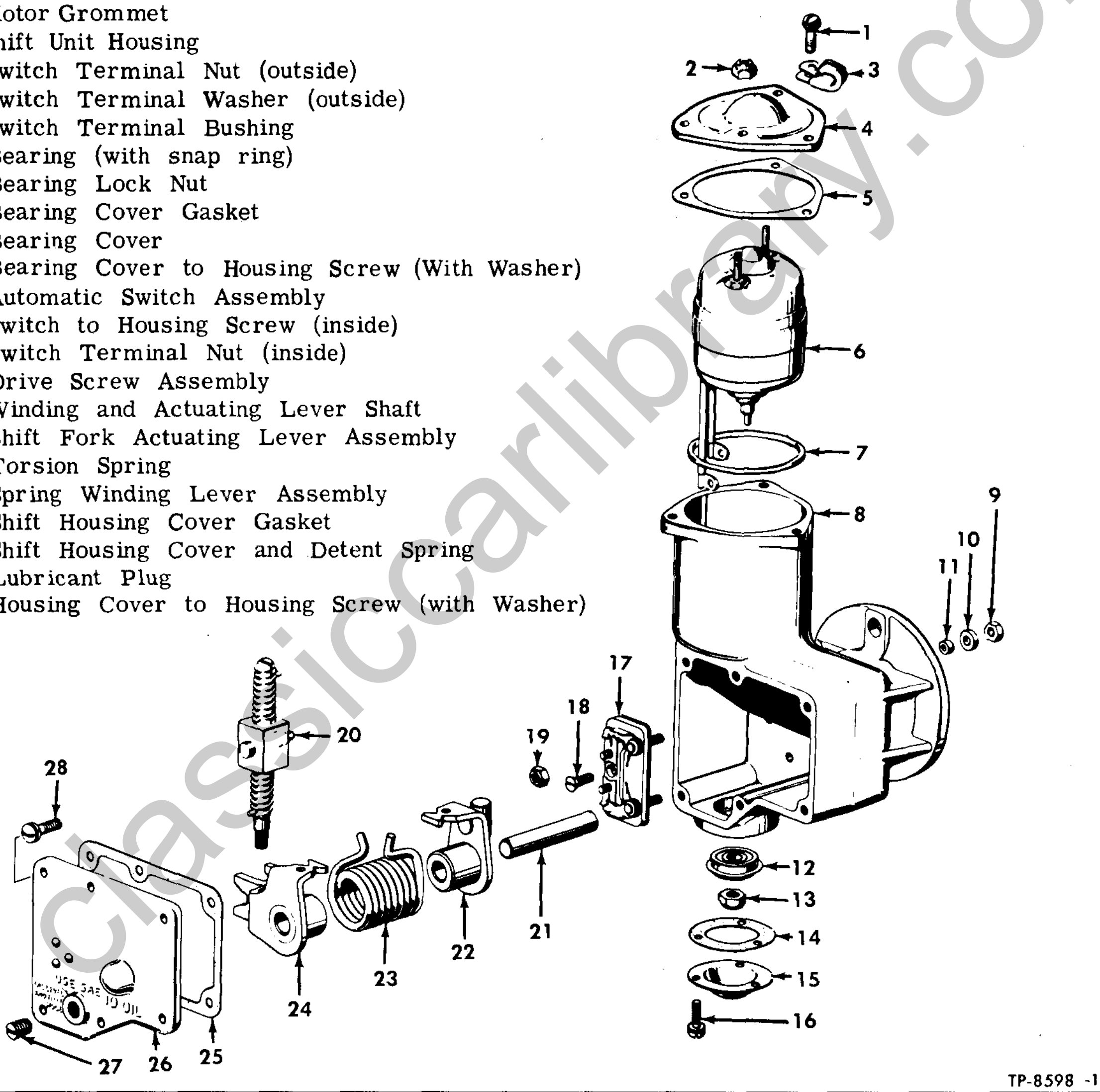


Figure 21—Electric Shift Unit Components (Eaton)

6. Reconnect air line to shift chamber.
7. Loosen lock nut and back off adjusting screw (fig. 12) several turns.
8. Shift to locked position with shift chamber being sure that sliding clutch engages drive gear.
9. Turn adjusting screw until it is finger tight against end of chamber shaft.
10. Turn adjusting screw ½ additional turn to center shift fork in sliding clutch groove, then tighten adjusting screw lock nut.

REMOVAL - VACUUM CHAMBER

1. Disconnect vacuum line from chamber.
2. Remove clevis pin attaching diaphragm rod yoke to lock-out shift lever (fig. 20).
3. Remove diaphragm retaining snap ring attaching shift chamber to mounting bracket, then remove chamber from bracket.

INSTALLATION - VACUUM CHAMBER

1. Position shift chamber to mounting bracket using dowel in bracket hole, then secure chamber to bracket using snap ring (fig. 20).
2. Install clevis pin attaching diaphragm rod yoke to lock-out shift lever. Whenever lock holes in yoke and lever do not line up, loosen lock nut and turn yoke on or off rod to obtain alignment, then tighten lock nut.

CONTROL VALVE REPLACEMENT

Inter-axle differential control valve is mounted to instrument board, on some models, directly behind control lever plate, while on other models valve is mounted to cab dash panel and is controlled by a push-pull rod. Replace as follows:

1. Disconnect air lines at valve.
2. Remove two screws attaching valve to mounting bracket, then remove valve assembly.
3. Position valve assembly to mounting bracket, then secure with two mounting screws.
4. Attach air lines to valve assembly. Check air lines for leaks.

OVERHAUL OF COMPONENTS

ELECTRIC SHIFT UNIT

The following information is provided on the assumption that shift unit has been tested and removed as previously instructed in this section.

DISASSEMBLY OPERATIONS (EATON AXLES)

Key numbers in text refer to figure 21.

1. Remove six screws (28) and lock washers which attach cover (26) to shift motor housing (8). Drain lubricant from housing. Remove gasket (25).
2. After removing cover (26), the drive screw (20) nut will be at either top or bottom depending upon the position in which the control switch was left.
3. By turning drive screw, run nut from top or bottom to the center of the screw (fig. 22).

IMPORTANT: The previous step is essential to prevent damage to drive nut contact bumper, and is also necessary in assembly.

4. Remove shift fork actuating lever (22), torsion spring (23), and spring winding lever (24) as an assembly by pulling shaft (21) up. Swing the assembly away from the drive nut and lift out of the housing (fig. 23).
5. Remove three screws and lock washers (16) which attach bearing cover (15). Remove

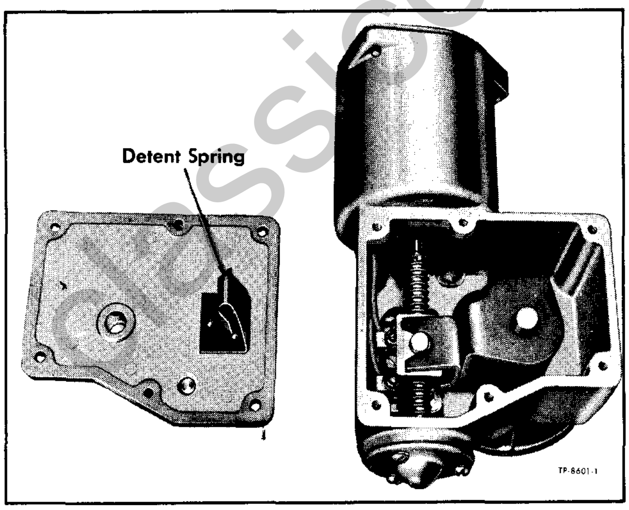


Figure 22—Position of Drive Nut When Disassembling

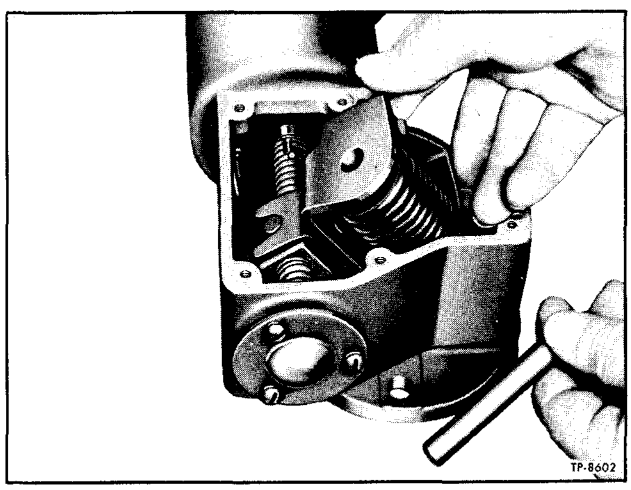


Figure 23—Removing Shaft, Actuating Lever, and Spring

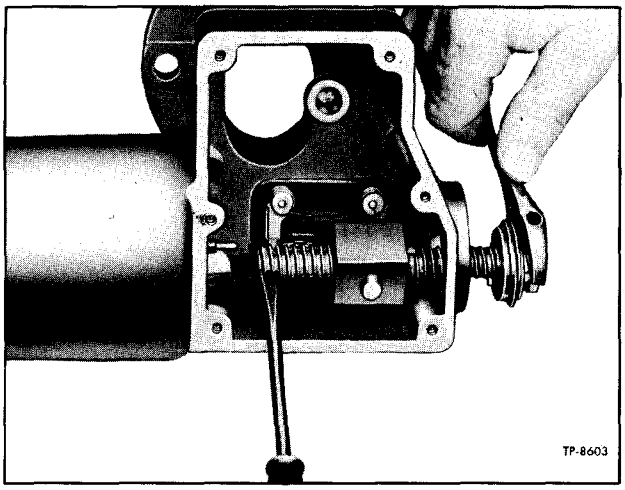


Figure 24—Removing Drive Screw Bearing

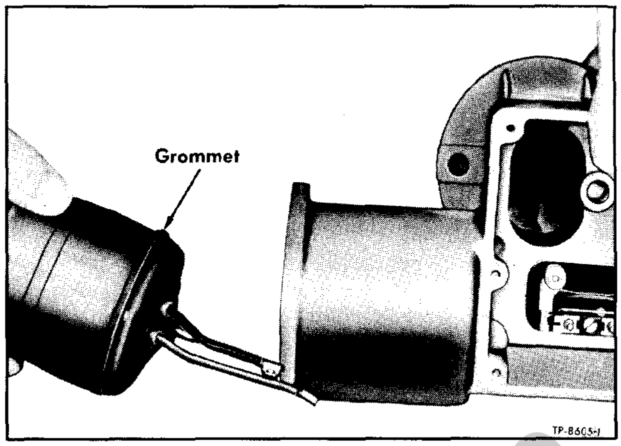


Figure 26—Removing Motor

cover and gasket (14).

6. Push down on drive screw assembly (20) until bearing assembly (12) is free of housing.

7. Insert screwdriver in drive slot of screw (fig. 24), then remove bearing lock nut (13) and bearing with snap ring (12). Drive screw assembly (20) can then be lifted out of housing.

8. Remove the two lock nuts (19) from switch terminals (17). Pull off motor wires (Fig. 25).

9. Remove three screws and lock washers (1) which attach motor cover (4) to housing. Pull out motor (6) with cover (4) attached to motor (fig. 26), with two cover nuts (2). Remove grommet (7).

10. Remove two jam nuts (9) and fiber washers (10) from outside of housing. On inside remove switch center screw (18). Pull out automatic switch (17) as shown in figure 27.

11. Do not disassemble the shift fork actuating lever (22), torsion spring (23), and spring winding lever (24) unless necessary to replace one of the parts. If necessary to disassemble, mount assembly in vise as shown in figure 28. Turn spring winding lever (24) clockwise and pull to separate.

DISASSEMBLY OPERATIONS
(ROCKWELL AXLES)

Key numbers in text refer to figure 29.

NOTE: Rockwell shift unit is partially disassembled during removal from differential housing as described earlier in this section under "Two-Speed Shift Unit Replacement." With the unit on the bench, balance of disassembly is the same as Eaton shift unit disassembly as illustrated in figures 24, 25, 26, and 27. Reference will be made to those illustrations during the following disassembly operations, and also in the assembly operations.

1. Remove three screws and lock washers (16) which attach bearing cover (15) to bottom of shift unit housing. Remove cover and gasket (14).

2. Push down on drive screw assembly (20)

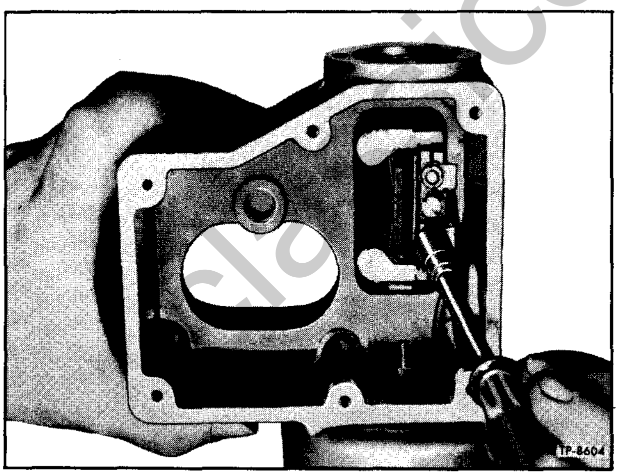


Figure 25—Removing Motor Wires

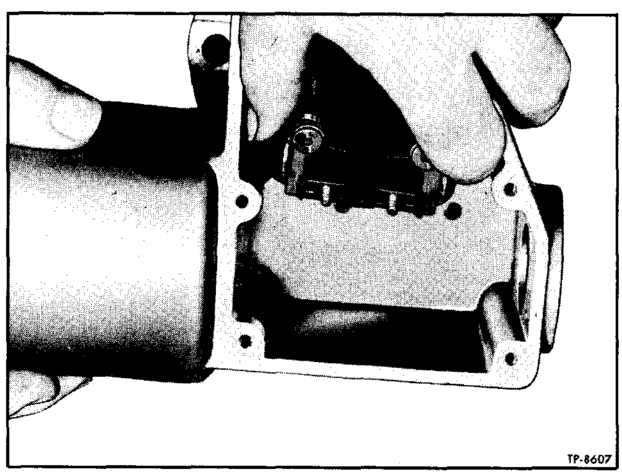


Figure 27—Removing Automatic Switch

until bearing assembly (12) is free of housing.

3. Insert screwdriver in drive slot of screw (fig. 24); then remove bearing lock nut (13) and bearing with snap ring (12). Drive screw assembly (20) can then be lifted out of housing.

4. Remove the two lock nuts (19) from switch terminals (17). Pull off motor wires (fig. 25).

5. Remove three screws and lock washers (1) which attach motor cover (4) to housing. Pull out motor (6) with cover (4) attached to motor (fig. 26). with two cover nuts (2). Grommet (7) can then be removed.

6. Remove two jam nuts (9) and fiber washers (10) from outside of housing. On inside remove switch to housing screws (18). Pull out automatic switch (17) as shown in figure 27.

7. Do not disassemble torsion spring (23), and spring winding lever (22) unless necessary to replace one of the parts. If necessary to disassemble, mount assembly in vise as shown in figure 30. Place a short piece of rod in hub of spring winding lever as a safety factor to prevent injury should torsion spring slip out of control. Next, place two lengths of tubing over ends of spring, pull spring ends apart, then raise spring above spring winding lever (fig. 31). To assemble; reverse above procedure.

CLEANING AND INSPECTION

Clean all parts except motor in cleaning solvent. Inspect as follows:

Automatic Switch

The switch assembly is serviced only as an assembly. The switch should have clean free moving points which close firmly under spring tension.

Drive Screw

The drive screw is serviced only as an assembly. While holding nut, rotate screw from one end to the other. It should rotate freely. When nut reaches either end of the screw, screw should continue to turn, and nut should not jam or turn off the ends.

Electric Motor

The motor (serviced only as an assembly) is reversible. With the motor housing connected to one battery terminal, and either one of the two motor wires connected to the other battery terminal the motor will run in one direction. With the other motor wire connected to the battery, motor will run in the opposite direction.

The motor has a stall torque of approximately 6 in.-lbs. Clamp a small crescent wrench on the rectangular drive on the armature shaft. Place motor in vise, and grasp wrench handle with one

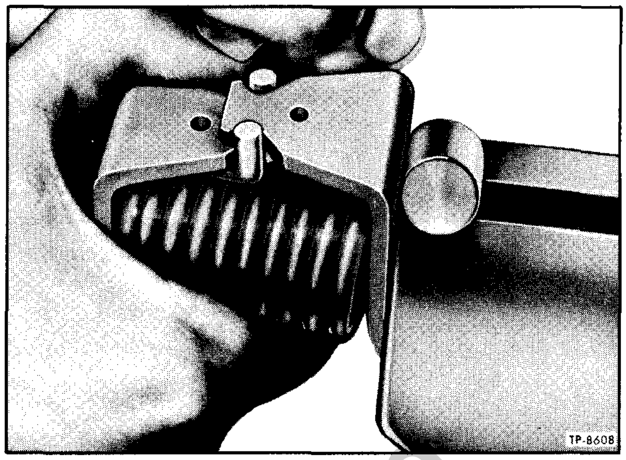


Figure 28—Disassembling Torsion Spring From Lever

hand. Connect one motor wire to a battery terminal and connect motor housing to the other battery terminal. The wrench should tend to turn with a torque of about 6 in.-lbs. Allow wrench to turn VERY SLOWLY, making sure that this pull or torque is present the FULL 360 degrees turn of the wrench. If one armature is burned out, the torque will disappear for a small part of the 360 degrees. Do not overheat the motor while making test. Motor must be replaced as an assembly, and is lubricated for life of motor. The motor used is 12-volt type which is the same as truck electrical system. When installing a new motor use care to select motor of proper voltage. Voltage is stamped on motor housing and side cover of shift unit.

Miscellaneous Parts

Gaskets should be replaced at assembly.

Inspect bearing. If balls are rough or chipped, replace with new bearing and snap ring assembly. Pack bearing assembly with clean grease (Chassis Grease) - Symbol "C" in LUBRICATION (SEC. 0).

Inspect torsion spring (25, figs. 21 and 29) for breaks or wear at lever contact points. Make certain that correct replacement spring is used.

ASSEMBLY OPERATIONS
(EATON AXLES)

Key numbers in text refer to figure 21.

1. Install automatic switch assembly (17) into housing. Use flat head screw (18) to attach switch to housing. On outside of housing, install two bushings (11), fiber washers (10), and jam nuts (9) over switch terminal screws. Tighten nuts firmly.

2. Install motor assembly grommet (7), then install gasket (5) on housing. Install motor (6) and cover (4) into housing. Install three screws and lock washers (1) and two stop nuts (2). Install motor cover cable clip (3) under outer screw. Tighten screws and nuts firmly.

3. Attach motor wires to switch terminals. The red or longer wire attaches to bottom terminal. Tighten inside terminal nuts (19) firmly.

4. With a screwdriver inserted into slot of drive screw (20), install bearing (12) on end of screw with shielded side of bearing toward inside. Retain bearing with bearing lock nut (13).

5. Run nut to center of screw, then insert slotted end of screw into housing, meshing slotted end with armature shaft.

NOTE: Fiber bumper contact on drive nut must be toward switch.

6. Install gasket (14) and cover (15) with three screws and lock washers (16). Tighten screws firmly.

7. If the assembly consisting of shift fork actuating lever (22), torsion spring (23), and spring winding lever (24) has been separated, reassemble. With shift fork actuating lever (22) in vise, assemble parts as shown in figure 32. Turn

1 Motor Cover to Housing Screw (with Washer)
2 Motor to Cover Nut
3 Motor Cover Cable Clip
4 Motor Cover
5 Motor Cover Gasket
6 Electric Motor
7 Motor Grommet
8 Shift Unit Housing
9 Switch Terminal Nut (outside)
10 Switch Terminal Washer (outside)
11 Switch Terminal Bushing
12 Bearing (with Snap Ring)
13 Bearing Lock Nut
14 Bearing Cover Gasket
15 Bearing Cover
16 Bearing Cover to Housing Screw (with Washer)
17 Automatic Switch Assembly
18 Switch to Housing Screw (inside)
19 Switch Terminal Nut (inside)
20 Drive Screw Assembly
21 Winding and Actuating Lever Shaft
22 Spring Winding Lever
23 Torsion Spring
24 Shift Housing Cover Gasket
25 Shift Housing Cover and Detent Spring
26 Lubricant Plug
27 Housing Cover to Housing Screw (with Washer)
28 Housing to Carrier Seal

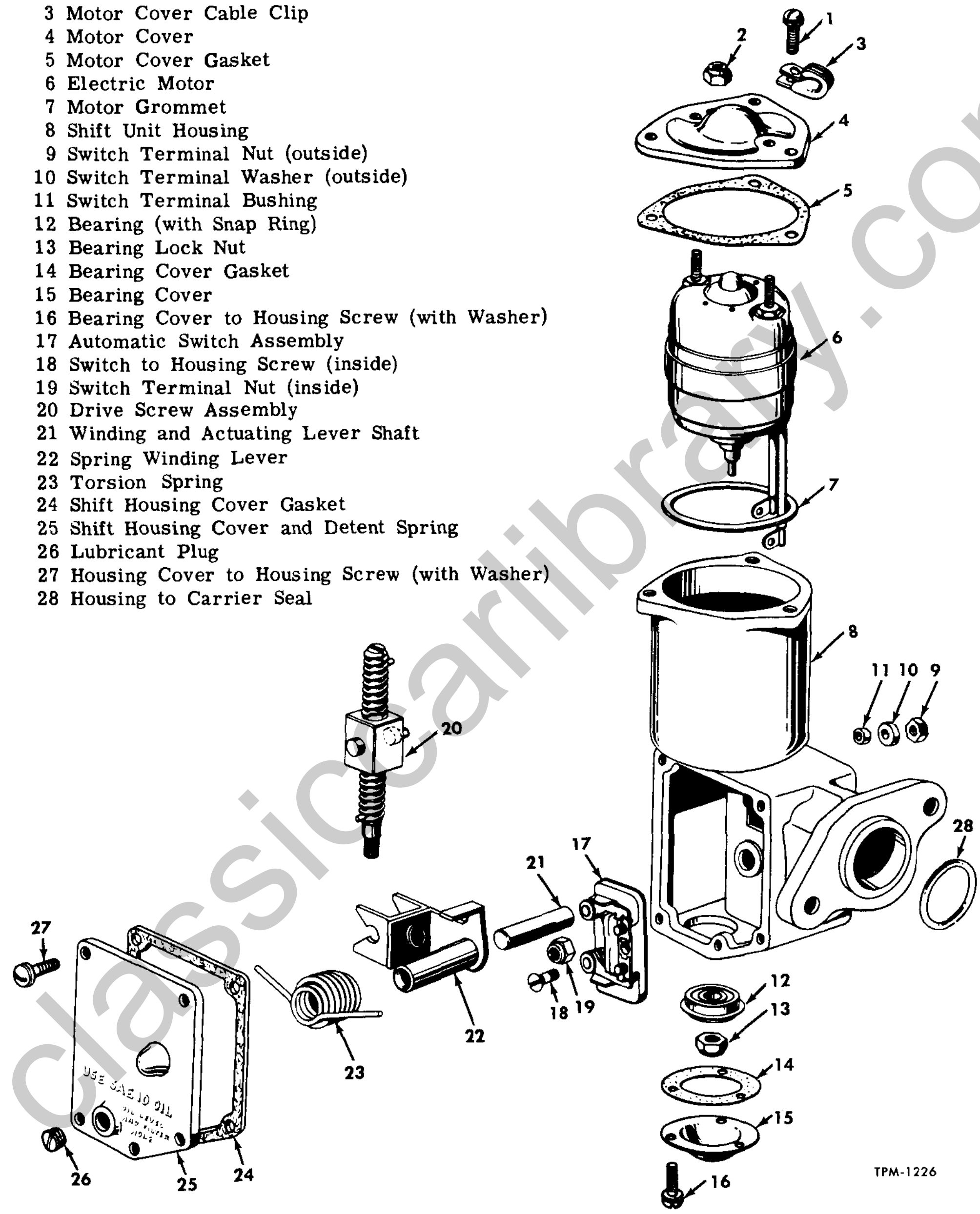


Figure 29—Shift Unit Components (Rockwell)

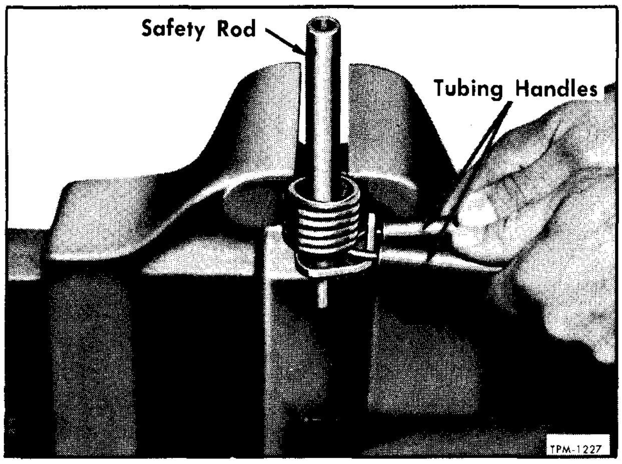


Figure 30—Removing Torsion Spring (Rockwell)

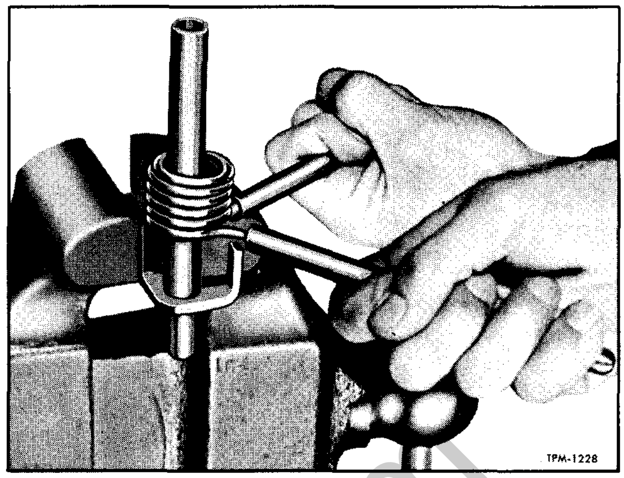


Figure 31—Removing Torsion Spring (Rockwell)

the spring winding lever (24) with one end of spring, in clockwise direction until end of spring is past shift fork actuating lever; then push in on assembly until positioned as shown in figure 28.

8. Dip above assembly in lubricant. With drive nut on drive screw assembly in center of screw, and fiber contact bumper down toward switch, position the slots of winding lever over the drive nut. Install the shaft (21) through center of assembly into depression in housing.

9. Install new gasket (25) on housing. Install cover (26) with spring detent against drive nut. Retain cover with screws and lock washers (28).

10. Remove oil plug (27). With unit standing with motor up, lubricate in accordance with instructions given in LUBRICATION (SEC. 0). Reinstall plug and tighten firmly.

ASSEMBLY OPERATIONS
(ROCKWELL AXLES)

Key numbers in text refer to figure 29.

1. Install automatic switch assembly (17) into housing. Use flat head screw (18) to attach switch to housing. On outside of housing, install two bushings (11), fiber washers (10), and jam nuts (9) over switch terminal screws. Tighten nuts firmly.

2. Install motor assembly grommet (7), then install gasket (5) on housing. Install motor (6) and cover (4) into housing. Install three screws and lock washers (1) and two stop nuts (2). Install motor cover cable clip (3) under outer screw. Tighten screws and nuts firmly.

3. Attach motor wires to switch terminals. The red or longer wire attaches to bottom terminal. Tighten inside terminal nuts (19) firmly.

4. With a screwdriver inserted into slot of drive screw (20), install bearing (12) on end of screw with shielded side of bearing toward inside. Retain bearing with bearing lock nut (13).

5. Run nut to center of screw, then insert slotted end of screw into housing, meshing slotted end with armature shaft.

NOTE: Fiber bumper contact on drive nut must be toward switch.

6. Install gasket (14) and cover (15) with three screws and lock washers (16). Tighten screws firmly.

NOTE: Remainder of assembly of shift unit used on Rockwell axles must be completed when unit is installed on housing as described previously in this section under "Two-Speed Shift Unit Replacement."

AIR TYPE CONTROL SWITCH

DISASSEMBLY

IMPORTANT: Air supply to control valve must be shut off before servicing the valve.

1. Remove screw from cover, then lift cover, shift knob, spring, shift plate, seal and seal guide

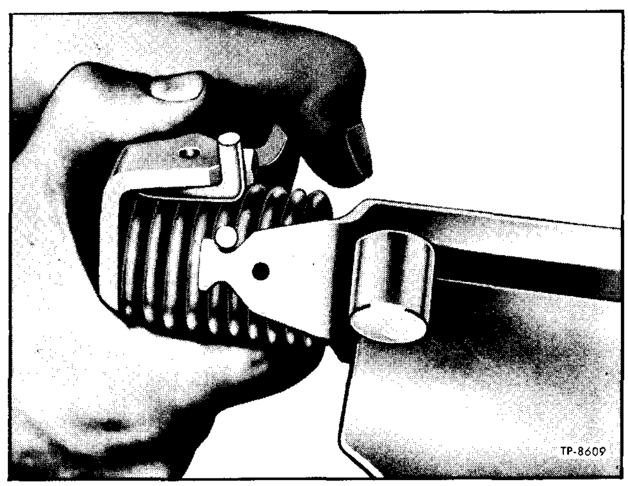


Figure 32—Assembling Torsion Spring and Levers (Eaton)

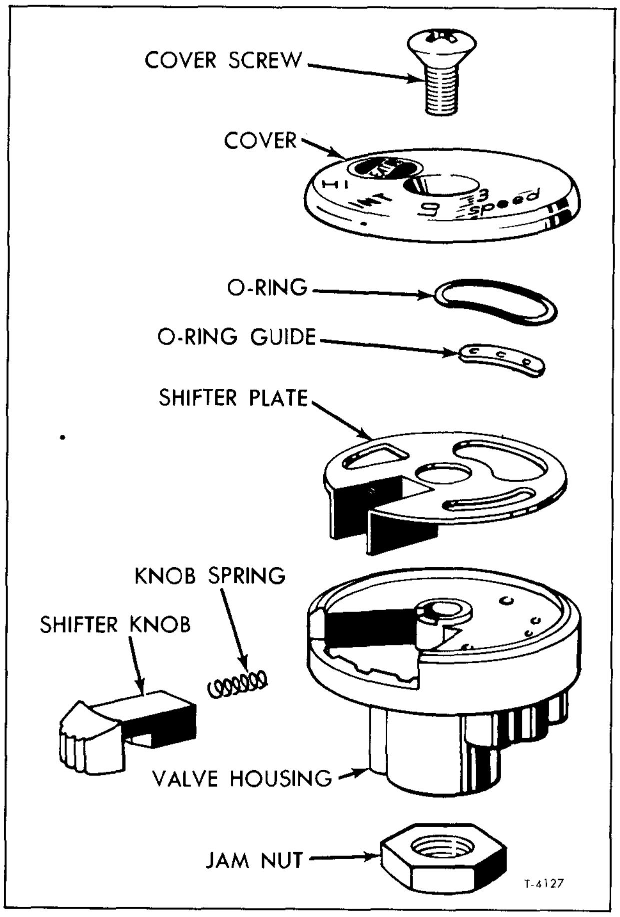


Figure 33—Control Switch Components (Air Type)

from valve housing. (Refer to figure 33.)

2. If housing requires replacement, disconnect air lines, then loosen jam nut and thread housing off lever.

ASSEMBLY

1. If housing was removed, turn onto lever for maximum thread and with "INT" at 11 o'clock position, then tighten jam nut.
2. Reconnect air lines and tighten connection securely.
3. Lubricate all parts with barium-base grease, then install shifter plate on housing.
4. Preassemble guide and seal, then place in position in shifter plate.
5. Hold shifter plate in housing while installing spring and shifter knob.
6. Install cover and secure with screw.

AIR SHIFT UNIT DISASSEMBLY

DISASSEMBLY

1. Remove bolts, lock washers, housing cover and gasket from shift unit housing. Drain lubricant.
2. Remove nuts and bolts retaining piston housing cover to unit. Remove piston housing cover and "O" ring seal.
3. Position housing in vise as shown in figure 35.
4. Install Tool J-8107, figure 36, over piston bore and clamp onto flange, install a 9/16" socket over self-locking nut and tighten down on tool until tension is relieved on clevis pin. Remove clevis pin (fig. 36).

NOTE: A bench vise may also be used to compress spring.

5. Unscrew Tool J-8107 until compression spring tension is relieved and remove Tool.
6. Push piston, push rod and compression spring through top of cylinder (fig. 37).
7. Remove actuating lever from housing.

INSPECTION

1. Inspect shift fork seal for good condition and tight fit on shift fork. Check shift fork seal spring for distortion and tension.
2. Inspect housing for cracks and cylinder bore for worn or grooved condition. Check piston stop cushion for worn or cracked condition.
3. Inspect piston for a worn or grooved condition. Check felt wipers for distortion. Felt wipers are oil soaked to insure proper lubrication of the cylinder wall. Check "O" rings for worn condition.
4. Inspect compression spring for distortion, tension and other visual defects. Check push rod and actuating lever for elongated holes, worn or cracked conditions.
5. Inspect bearing surface on actuating arm for wear.
6. Inspect bushings in both the housing and housing cover for wear.
7. Replace faulty or doubtful parts.

REASSEMBLY

1. Soak felt wipers in SAE-30 oil for one hour and install felt wipers, and new "O" ring on piston.
2. Install piston stop cushion in cylinder bore if removed.
3. Install actuating lever in housing.
4. Install piston and washer on push rod and torque self-locking nut to 135 in. lbs. Install push rod spring and piston into cylinder bore. Care must be taken to insure proper fit of felt wipers and "O" ring on piston.
5. Compress spring, then install clevis pin at push rod and actuator arm connection (fig. 36).
6. Install housing cover and gasket. Torque cover screws to 100 in. lbs.
7. Install new "O" ring in housing and install piston housing cover. Torque piston housing cover nuts to 120 in. lbs.

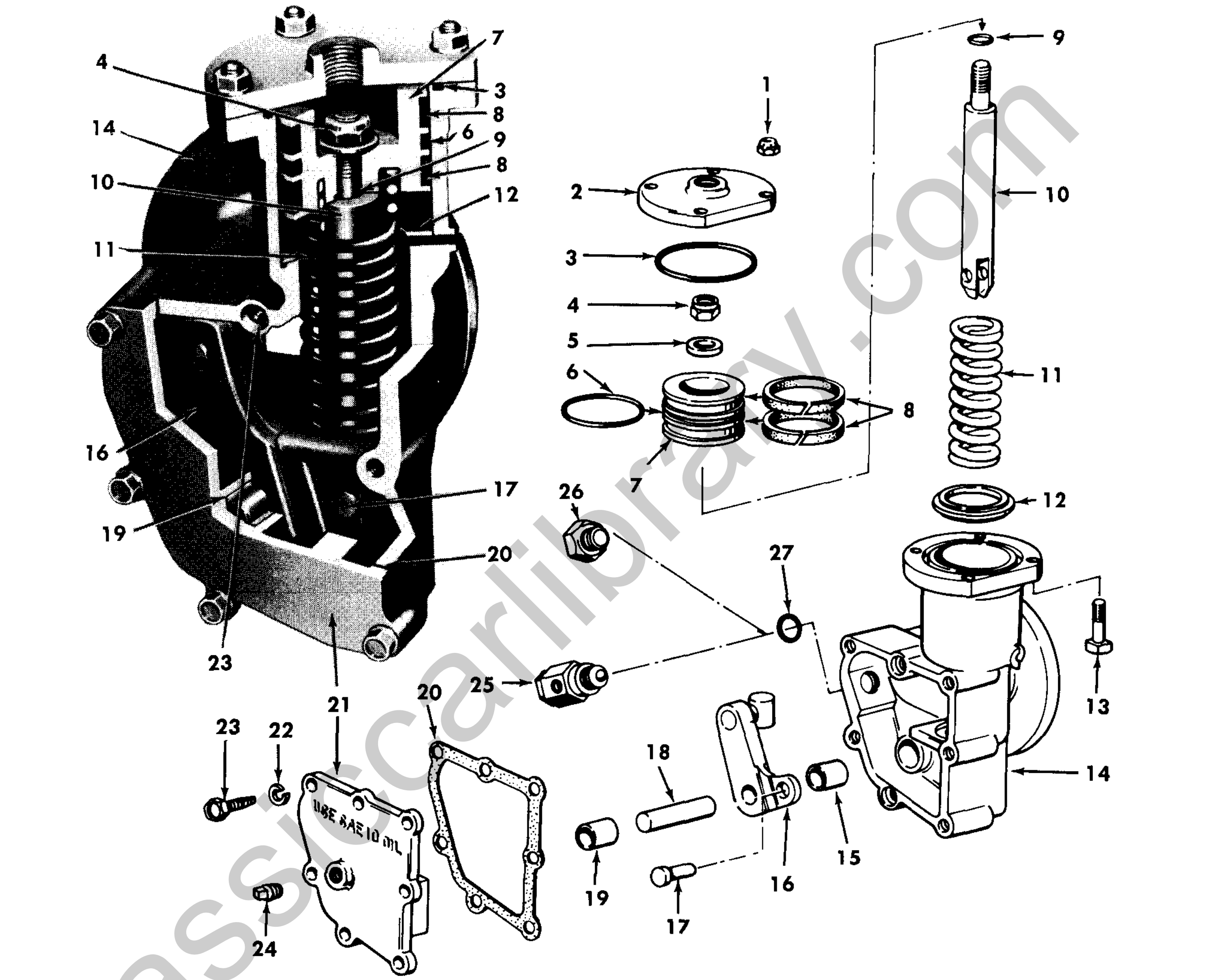
AIR SHIFT CHAMBER OVERHAUL

On some rear axles equipped with inter-axle differential lock, an air shift chamber is used to shift the inter-axle into a locked position. Chamber has been removed as instructed previously in this section.

NOTE: Thoroughly clean air shift chamber before disassembling to prevent dirt entering unit.

DISASSEMBLY (Fig. 38)

1. Before disassembling, mark both halves of chamber, also clamp ring so that these parts will be in their proper relation to each other at reassembly.
2. Remove clamp ring bolts, then spread clamp ring and remove.
3. Remove chamber cover and diaphragm.
4. Pull shift rod and plate from chamber body.



1 Nut	10 Push Rod	19 Cover Bushing
2 Housing Cover	11 Compression Spring	20 Cover Gasket
3 O-ring Seal	12 Piston Stop	21 Cover Assembly
4 Nut	13 Cover Bolt	22 Lock Washer
5 Washer	14 Housing	23 Cover Screw
6 Piston O-ring Seal	15 Housing Bushing	24 Cover Plug
7 Piston	16 Actuating Lever Assembly	25 Lock-out Valve (Fwd. Axle)
8 Piston Felt	17 Clevis Pin	26 Housing Plug
9 Piston O-ring Seal	18 Actuating Lever Pin	27 O-ring

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Figure 34—Three-Speed Air Shift Unit Components

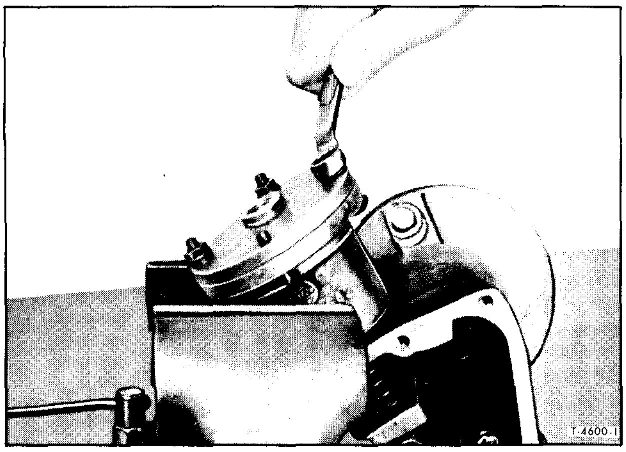


Figure 35—Piston Cover Removal or Installation

5. Remove air cleaner and oil seal from chamber body.

CLEANING AND INSPECTION

1. Immerse all metal parts in cleaning solution to remove all oil, grease, and foreign matter.
2. Inspect diaphragm and replace if evidence of wear or deterioration is present.
3. Inspect shift rod for excessive wear.
4. Inspect chamber body and cover for damage that would affect proper function.

ASSEMBLY (Fig. 38)

1. Install new oil seal in chamber body with lip of seal toward outside.
2. Install air cleaner and retainer.
3. Install shift rod and plate in chamber body, being careful that lip of oil seal is not damaged.
4. Install diaphragm and chamber cover on chamber body, being careful that diaphragm is evenly positioned.
5. Install clamp ring and secure with two bolts and nuts.

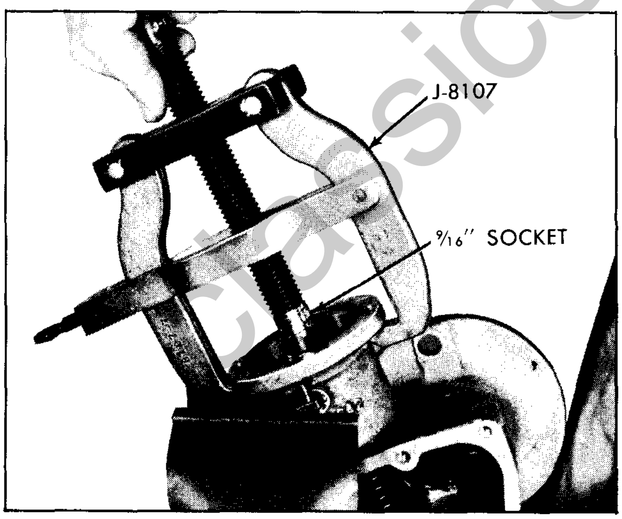


Figure 36—Clevis Pin Removal or Installation

VACUUM SHIFT CHAMBER OVERHAUL

On some rear axles equipped with inter-axle differential lock a vacuum shift chamber is used to shift inter-axle into a locked position.

DISASSEMBLY (Fig. 39)

1. Remove rubber boot from diaphragm rod and yoke.
2. Loosen yoke nut, then thread yoke and nut from diaphragm rod.
3. Remove nut, bolts, and washers attaching chamber outer cover to inner cover, then remove cover.
4. Remove diaphragm and rod assembly from inner chamber.
5. Remove diaphragm nut, then remove diaphragm, washers, and plates from diaphragm rod.

CLEANING AND INSPECTION

1. Clean all metal parts thoroughly, using a suitable cleaning fluid.
2. Inspect diaphragm and all other parts for damage or deterioration. Parts showing evidence of damage or wear should be replaced.

REASSEMBLY (Fig. 39)

1. In the order listed install following parts on diaphragm rod: Nut, plain washer, small diaphragm plate, diaphragm, large diaphragm plate, plain washer, and nut.
2. With above parts centered on diaphragm rod, tighten retaining nut. Stake rod threads to prevent nut loosening.
3. Install diaphragm and rod assembly into inner chamber, then position outer chamber over

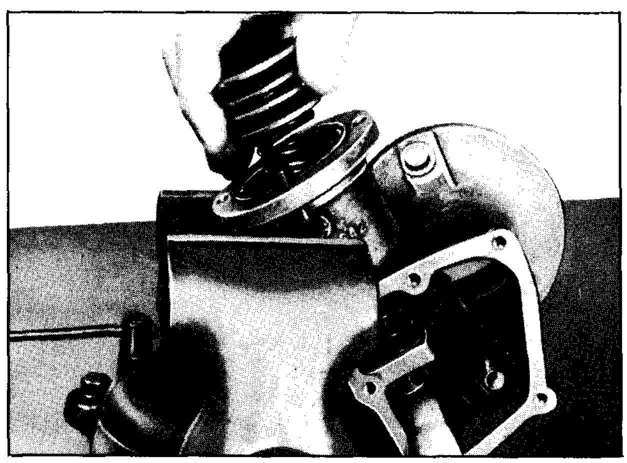
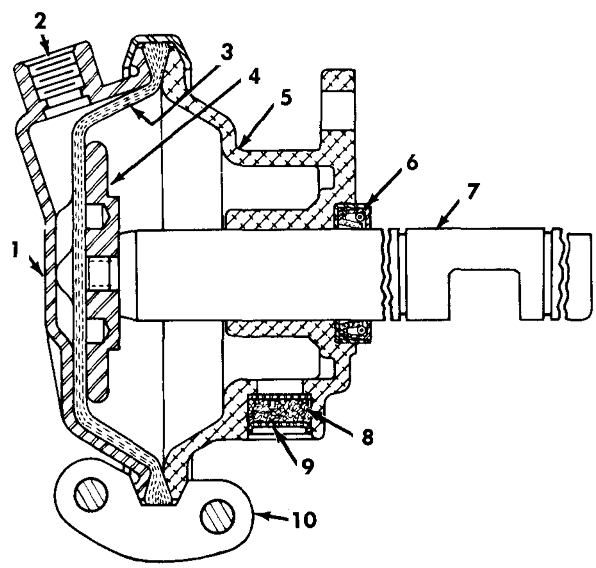


Figure 37—Removing or Installing Piston, Push Rod, and Spring



1 Chamber Cover	6 Oil Seal
2 Air Inlet	7 Push Rod
3 Diaphragm	8 Felt
4 Pressure Plate	9 Felt Retainer
5 Chamber Body	10 Clamp w/Bolts

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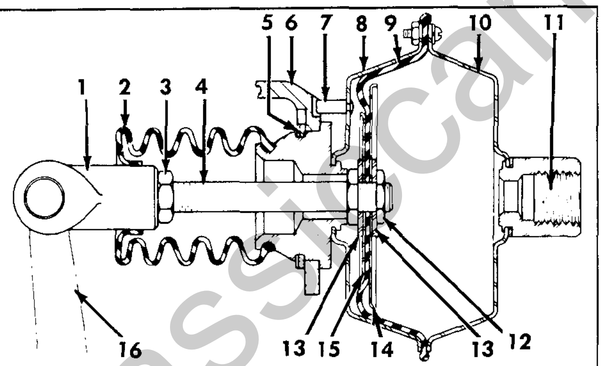
Figure 38—Inter-Axle Air Shift Chamber

inner chamber with diaphragm between inner and outer chambers.

4. Install six bolts, washers, and nuts attaching two halves of chamber and diaphragm together. Tighten nuts evenly and securely.

5. Install boot and yoke on diaphragm rod.



1 Adjustable Yoke	11 Vacuum Inlet
2 Boot	12 Diaphragm Nut
3 Lock Nut	13 Plate Washer
4 Diaphragm Rod	14 Diaphragm Plate (Large)
5 Snap Ring	15 Diaphragm Plate (Small)
6 Mounting Bracket	16 Shift Lever
7 Locating Dowel	
8 Chamber Half (Inner)	
9 Diaphragm	
10 Chamber Half (Outer)	

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Figure 39—Inter-Axle Vacuum Shift Chamber

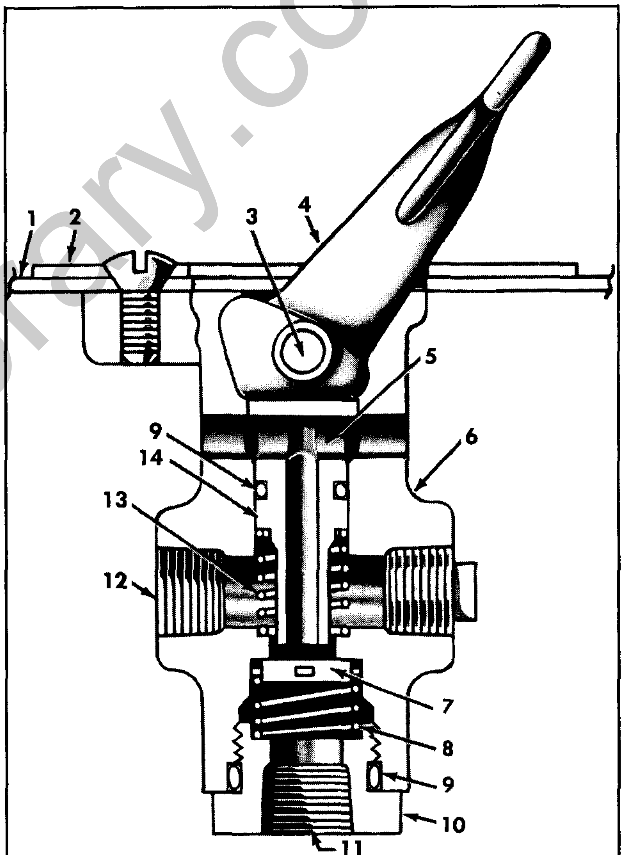
INTER-AXLE DIFFERENTIAL CONTROL VALVE

Inter-axle differential control valve assembly is used to control air or vacuum at shift chamber located at rear axle. Valve is located at instrument panel and is removed as previously directed in this section.

DISASSEMBLY (Fig. 40)

1. Using a small drift, drive out fulcrum pin securing control lever in valve body. Remove lever.

2. Remove cap nut, O-ring, valve spring, and valve disc from bottom of body.



1 Instrument Panel	9 O-ring
2 Name Plate	10 Cap Nut
3 Fulcrum Pin	11 To Intake Manifold or Air Tank
4 Control Lever	12 To Shift Cylinder
5 Exhaust Port	13 Plunger Spring
6 Body	14 Plunger
7 Valve Disc	
8 Valve Spring	

TPM-9006-1

Figure 40—Inter-Axle Differential Lock Control Valve

3. Push against bottom of valve plunger to remove plunger from top of body. Remove plunger spring from body and remove O-ring from plunger.

CLEANING AND INSPECTION

Wash all metal parts in cleaning fluid. Carefully examine small end of plunger which contacts valve; if any roughness or damage is evident, replace plunger. Inspect valve seat in body; if seat shows wear or damage, replace body. Replace valve disc if any wear or damage is evident. Replace valve spring if rusted or corroded.

ASSEMBLY (Fig. 40)

1. Install new O-ring in groove in plunger and on cap nut. Coat plunger with grease containing zinc oxide, then place spring on small end of plunger, and install plunger and spring in body.
2. Install control lever in body and secure with fulcrum pin. Stake pin in place.
3. Turn body bottom side up and install valve disc, valve spring, and cap nut, being sure new O-ring is in place on cap nut. Tighten cap nut.
4. After installing valve in vehicle, or using a test hook-up, test valve as previously directed under "Maintenance on Vehicles."

REAR AXLE TORQUE SPECIFICATIONS

ITEM	TORQUE (FT. LB.)
DRIVE PINION YOKE NUT	
Eaton	
1⅛″—18	325-450
1¼″—12	400-600
1½″—18	500-700
Rockwell	
1″—20	300-400
1¼″—18	700-900
1½″—18	800-1100
INPUT SHAFT YOKE NUT	
Eaton 30DS and 34DS	350-500
OUTPUT SHAFT YOKE NUT	
Eaton 30DS and 34DS	350-500
DIFFERENTIAL CARRIER TO HOUSING	
Eaton	
½″—13 Cap Screw	75-85
⅝″—11 Cap Screw	160-175
⅝″—18 Stud Nut	220-240
Rockwell	
½″—20 Stud Nut	80-105
⅝″—18 Stud Nut	160-205
OIL SEAL RETAINER AND PINION CAGE	
Eaton—9/16″—12	115-125
Rockwell	
7/16″—14	55-70
½″—13	80-105
9/16″—12	115-150
SHIFT CHAMBER	
Stud Nut—⅜″—24	30-35
INTER AXLE SHIFT HOUSING	
Cap Screw—7/16″—14	30-35
THRU-SHAFT BEARING CAGE	
Cap Screw—⅜″—16	35-45
AXLE SHAFT FLANGE STUD NUT	
½″	50-60
⅝″	90-110

REAR SPRINGS AND SUSPENSION

This section consists of subjects listed in Index below:

NOTE: All spring attachments, including center bolts, are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with parts of the same part numbers or with equivalent parts if replacement becomes necessary. Do not use replacement parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

LEAF SPRING (SINGLE AXLE—LINK TYPE)

The progressive type, two-stage, rear springs, shown in figures 1 and 2, have a straight ended main leaf which rests against the cam surface of the front and rear hangers, thereby allowing the springs a full fore and aft float to effect spring length changes. The second or third leaf on all forward control and tilt models has hooked ends which contact rebound pins in the spring hanger to prevent excessive fore and aft travel in event of radius leaf rod failure. The radius leaf rods maintain axle alignment and transmit driving and braking forces to the frame.

On tilt cab models, a spacer is used at bottom of spring pile to separate the last leaf from the radius leaf which is half-leaf formed with an eye and bushed for attachment to the front hanger. Two slanted U-bolts attach the spring pile and radius leaf to the axle housing.

On conventional cab models, the torque rods have an eye and bushing at each rod end.

REAR SPRING REPLACEMENT

REAR SPRING REMOVAL

1. Remove bolts and lock washers used to hold rebound pin locks or retainers to spring brackets. Pins are installed flush with surface of bracket with retainer hooked over side of bracket; or the locks fit into a groove in the rebound pin. Refer to figure 3 and remove rebound pins.
2. Install a C-clamp on radius leaf to relieve load on radius leaf eye bolt or radius leaf pin except on conventional cab models. On all except steel tilt 70-80 Models, remove eye bolt, then remove C-clamp. On other models, remove clamp bolts which retain radius leaf pin. Remove lubrication fitting and install adapter in radius leaf pin. Attach slide hammer to adapter (J-8118) and withdraw spring eye pin from bracket (fig. 4). On conventional cab models, remove bolt attaching radius leaf to rear mounting bracket.
3. Remove nuts from U-bolts, then remove U-bolts and U-bolt spacer plate from springs. Remove shock absorber bracket (when used) from lower axle. Raise frame to relieve weight.
4. Remove spring and spacer (when used) or tapered shim (when used) from axle.

NOTE: When tapered shim is used, note position of shim to ensure proper installation.

5. Inspect spring. Replace bushing and repair or replace spring unit if worn, damaged or weak.

SPRING LEAF REPLACEMENT

NOTE: Auxiliary springs should be disassembled in an arbor press or vise. When assembling springs, make sure spacer is installed between the auxiliary and main spring.

1. Mark one side of spring assembly to assure original position of springs when assembling.
2. Place spring in a vise and remove spring clip, bolt, nut, and spacer.
3. File peened end of center bolt and remove center bolt nut.
4. Open vise slowly and carefully to let spring assembly expand. Clean spring leaves.
5. Replace weak or broken spring leaf.
6. Align center holes in springs using a long drift.
7. Compress spring leaves in a vise, then remove drift and install a new center bolt.
8. Install nut on center bolt and tighten securely. Peen end of bolt to prevent nut from loosening.
9. Align spring leaves by tapping with a hammer and install spring clip, bolts, spacers, and nuts.

SPRING EYE RUBBER BUSHING REPLACEMENT (WITH RADIUS LEAF REMOVED)

Remove and replace radius leaf eye bushing using bushing remover and installer (J-21058) as shown in figure 5.

REAR SPRING INSTALLATION

1. Set spring assembly and tapered shim or spacer (if used) at the axle pad with radius leaf eye toward the bracket having spring eye pin or bolt hole.

IMPORTANT: Tapered shim must be installed on axle in same position noted at removal.

NOTE: If auxiliary springs are used, place spring assembly and spacer in position.

NOTE: If all rust or scale build-up is not removed from spring leaves at center near U-bolts, U-bolts will eventually work loose.

2. Install U-bolt spacer over center bolt on top leaf spring.

3. Seat U-bolts in spacer and secure spring

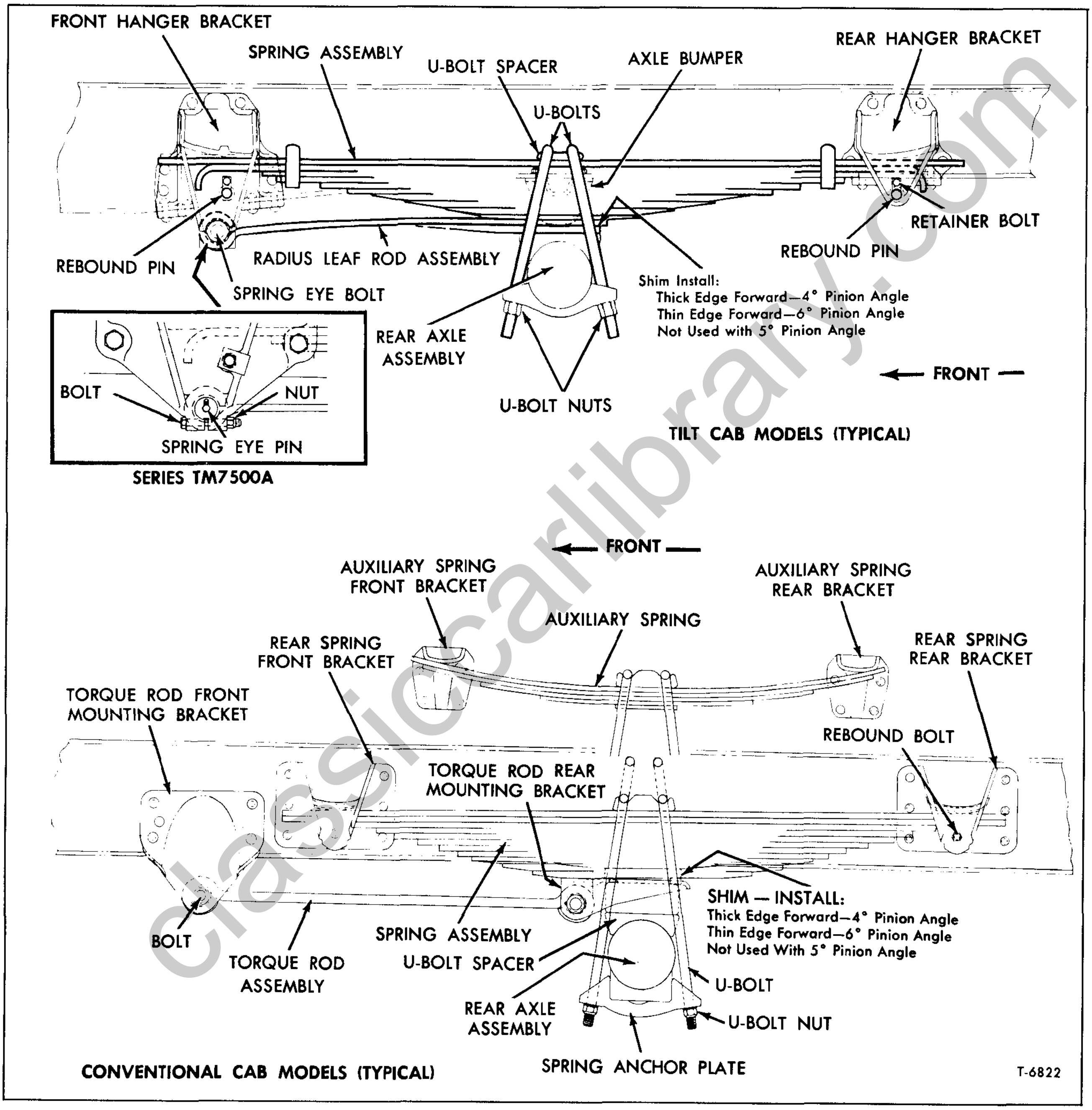


Figure 1—Link Type Rear Suspension (Typical)

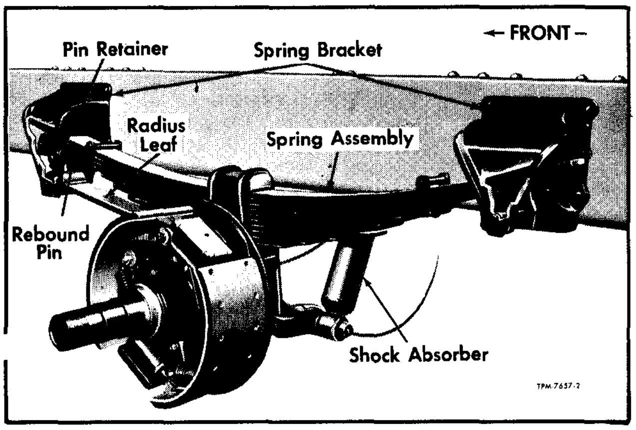


Figure 2—Radius Leaf Type Rear Suspension

to axle by installing anchor plate and nuts on U-bolts. Tighten nuts to torque listed in "Specifications" at end of this section.

4. Lower frame until end of spring enters hanger.

5. Compress radius leaf with a C-clamp until radius leaf eye and hanger holes are aligned.

a. On all models, insert radius leaf retainer bolt through leaf and hanger. Tighten bolt to torque listed in "Specifications."

6. Remove C-clamp from radius leaf, lower vehicle, and install rebound pin at front and rear hangers. On all steel tilt models install rebound pins with lock groove flush with surface of brackets, install locks, and secure with lock bolt. Bend tab of lock over flat of retaining bolt. On other models, drive rebound pin in flush with bracket surface, then hook retainer over edge of brackets and install bolt and lock washer to secure each retainer (fig. 2).

7. On vehicles using shock absorbers, connect lower end of shock absorber bracket and tighten nuts to torque listed in "Specifications" at end of this section.

8. On other models using pins, install fitting and lubricate radius leaf anchor pin. Refer to LUBRICATION (SEC. 0) in this manual, for type of lubricant.

9. Remove blocking and lower frame to place weight on springs. Check U-bolt nuts for proper torque. Refer to "Specifications" at end of this section for torque.

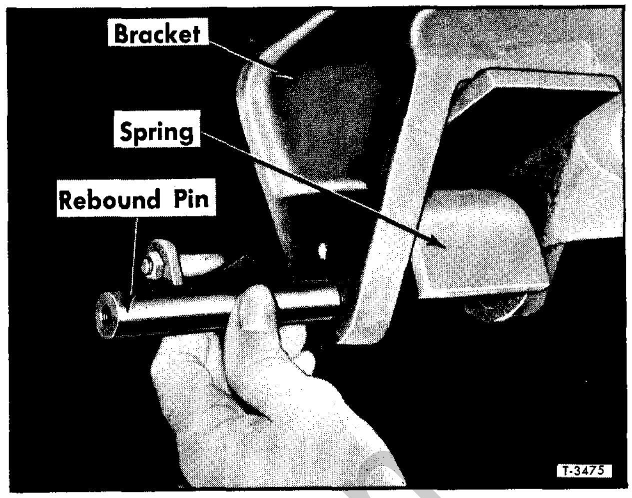


Figure 3—Removing or Installing Rebound Pin (Typical)

REPLACING RADIUS LEAF EYE BRONZE BUSHING (WITH SPRING ASSEMBLY IN VEHICLE)

REMOVAL (Fig. 6)

1. Jack up vehicle frame so that forward, hooked end of spring leaf touches rebound stop pin.
2. Remove spring eye pin clamp bolts.
3. Compress radius leaf with a heavy duty C-clamp to relieve tension of radius leaf on eye pin, then remove lubrication fitting from pin.
4. Install adapter (J-8118) into lubrication fitting hole in end of radius leaf pin and use slide hammer to withdraw radius leaf pin (fig. 4).

NOTE: It may be necessary to drive radius leaf pin out with a drift and hammer.

5. Release C-clamp to allow radius leaf to

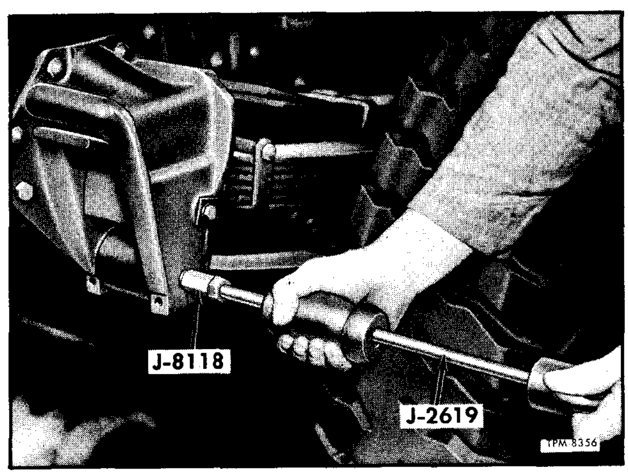


Figure 4—Removing Radius Leaf Pin with Slide Hammer and Adapter

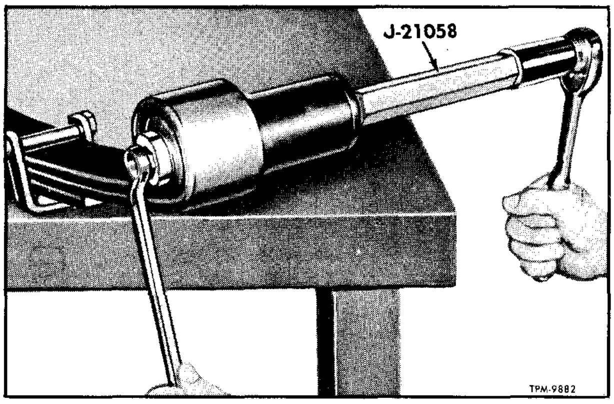


Figure 5—Replacing Rubber Type Eye Bushing

drop below bracket, then using bushing remover and installer (J-8459) replace spring eye bushing as follows:

a. Place large O.D. of guide (J-8459-4) over threaded end of shaft (J-8459-1), then lubricate threads of shaft and insert threaded end of shaft through radius leaf bushing from inner side.

b. Install sleeve (J-8459-5), stop (J-8459-2), bearing, washer, and nut (J-8459-6), over threaded end of shaft. Hold shaft from turning and use a socket wrench with a long handle to turn nut and draw the radius leaf bushing out.

c. Disassemble tool assembly (J-8459).

INSTALLATION (Fig. 7)

1. Install new radius leaf bushing using special tool assembly (J-8459) as follows:

Figure 6—Removing Spring Eye Bushing

a. Assemble large O.D. of guide (J-8459-4) over threaded end of shaft (J-8459-1); then lubricate radius leaf spring eye, bushing, and shaft threads.

b. Install bushing over shaft and insert threaded end of shaft through inner side of radius leaf spring eye. Install stop (J-8459-2), bearing, washer, and nut (J-8459-6) over threaded end of shaft.

c. While holding shaft to prevent turning, tighten nut (J-8459-6) to draw bushing into the radius leaf spring eye until bushing contacts stop (J-8459-2).

d. Check radius leaf pin for slip fit in bushing and ream bushing as necessary.

2. With frame raised so hooked spring leaf just contacts rebound pin, use a heavy duty C-clamp to draw radius leaf spring eye into alignment with hole in bracket. Install the radius leaf pin with hole for lubrication fitting facing out. Index notch on end of radius leaf pin with clamp bolt holes in spring bracket.

3. Install clamp bolts, nuts, and lockwashers, then install lubrication fitting in pin and lubricate with lubricant specified in LUBRICATION (SEC. 0) in this manual.

4. Remove C-clamp and lower frame to place weight on springs.

AUXILIARY SPRINGS

Some vehicles have auxiliary rear springs which are necessary for certain types of operation. When used, the auxiliary spring leaves are installed above the regular rear spring assembly and are held in place by long U-bolts which secure main spring and helper to axle. Brackets are installed on frame and are contacted by the auxiliary spring to provide added stability required for unusual conditions. An air gap between helper spring and

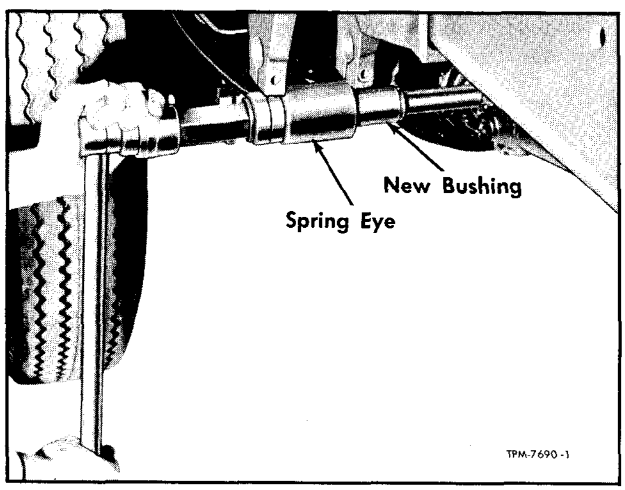


Figure 7—Installing Spring Eye Bushing

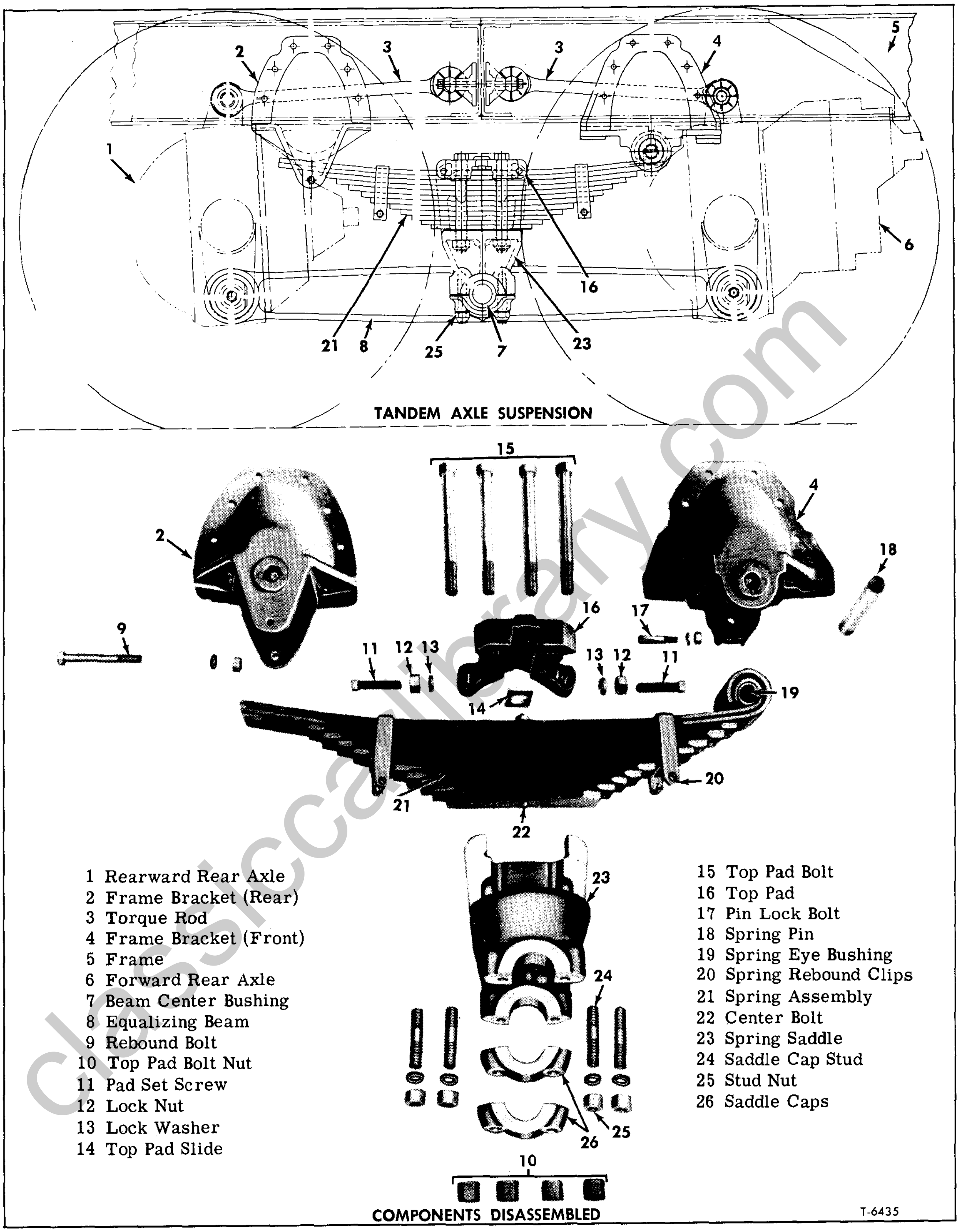


Figure 8—Tandem Rear Axle Suspension (Hendrickson RT) (Typical)

pad is provided for empty vehicle to ensure a soft ride.

SHOCK ABSORBERS

Shock absorbers, used as standard or optional equipment on some vehicles, are non-adjustable and non-repairable. Maintenance operations are limited to replacement of rubber mounting grommets and periodically tightening all mountings. If a shock absorber becomes inoperative, the complete unit must be replaced.

CAUTION: When replacing a shock absorber, check the model number stamped on the unit to make sure it is the same model as the one removed. Defective shock absorbers will permit springs to bottom, causing poor ride, with the possibility of broken springs as a result.

HENDRICKSON TANDEM REAR SUSPENSION

DESCRIPTION

In the Hendrickson RT and RU type suspension equalizing beams are used to tie front and rear axles together, and permit independent vertical movement of each axle as required by road surface. Road shocks are partially absorbed through use of rubber bushings at beam center, ends, and torque arms. Driving and braking forces are transmitted to the vehicle chassis through non-adjustable solid torque rods and the equalizer beams. The springs carry the load and maintain transverse relationship of frame to axle. Torque rods are positioned to maintain proper drive line alignment and stabilize driving and braking forces.

The basic difference between the RT and RU type suspension is that the RT-type embodies a spring top saddle pad that uses bolts in place of U-bolts to secure spring to axle. The RU-type employs solid front and rear torque rods and uses U-bolts to secure springs to axle. Figures 8 and 9 show typical arrangement of Hendrickson suspension units described.

The Hendrickson RS 380 suspension shown in figure 10 uses rubber load cushions to absorb load and road shock. The rubber load cushion is an innovation in tandem suspensions wherein the rubber replaces the normally used steel leaf spring.

Positive mounting between the frame and the suspension unit is secured by four rubber bushed drive pins, one for each load cushion. These bushings permit the drive pins to move up and down in direct relation to the movement of the load cushion. Figure 10 shows a cut-away of the load cushion.

Periodic lubrication has been fully eliminated by the use of the rubber load components.

TANDEM UNIT REMOVAL AND INSTALLATION

When a major overhaul is required, the complete tandem unit should be removed from the frame; however, torque rods, springs, equalizing beams, and other parts may be removed separately as required.

Component parts may also be removed from RS-380 rubber cushion suspension and will be described later in text.

CAUTION: Before removing the tandem unit, use jacks and other equipment to block vehicle securely to prevent axle assemblies from rolling or pivoting at equalizer beam ends when torque rods are disconnected.

REMOVAL - RT AND RU MODELS
(Refer to Figures 8 and 9)

NOTE: The following procedure explains the method whereby the spring eyes are separated from frame brackets. However, if frame can be raised to any height and the spring forward brackets are bolted to frame and not riveted, separation can be made between brackets and frame rails. Also, it would not be necessary to remove the forward duals.

1. Block wheels on rear axle and disconnect brake lines from axles. Raise and safely support forward axle then remove forward duals.

2. Disconnect propeller shaft from forward rear axle as explained in "PROPELLER SHAFTS" (SEC. 4D) in this manual.

3. Raise vehicle frame to remove load from springs. Support frame securely and remove rebound bolt from bottom of spring rear bracket.

4. Remove lock bolt securing spring pin in front bracket. Remove lubrication fitting from inner end of pin. In some cases pin may be removed with slide hammer and adapter from inner side of hanger. If this is not possible, remove pin using soft drift and hammer from outer side of hanger.

5. Temporarily install single wheel on each side of front axle so assembly can be removed from under chassis.

6. Place jacks and other equipment at each

axle to prevent axle assemblies from rolling or pivoting at equalizer beam ends when torque rods are disconnected.

7. At each axle end, remove nut from torque rod end stud and drive end stud out of axle bracket using a soft hammer.

8. Using a suitable hoist, raise rear end of frame and roll axles, with equalizer beams and springs, out from under frame.

REMOVAL - RS-380 TYPE
(Refer to Fig. 10)

1. On the RS-380 rubber cushion type suspension the first two steps of the above RT and RU procedure apply with the exception of removing front duals. It is also necessary to accomplish the following:

2. Remove the 28 side and lower suspension hanger attaching bolts securing hangers to frame.

3. With axle housings secured safely, disconnect torque rods at axle ends by removing nuts then driving ends from brackets with soft drift and hammer.

4. Raise frame until sufficient clearance exist, then carefully roll entire assembly from under frame.

5. Lower frame to safety stands or other suitable supports.

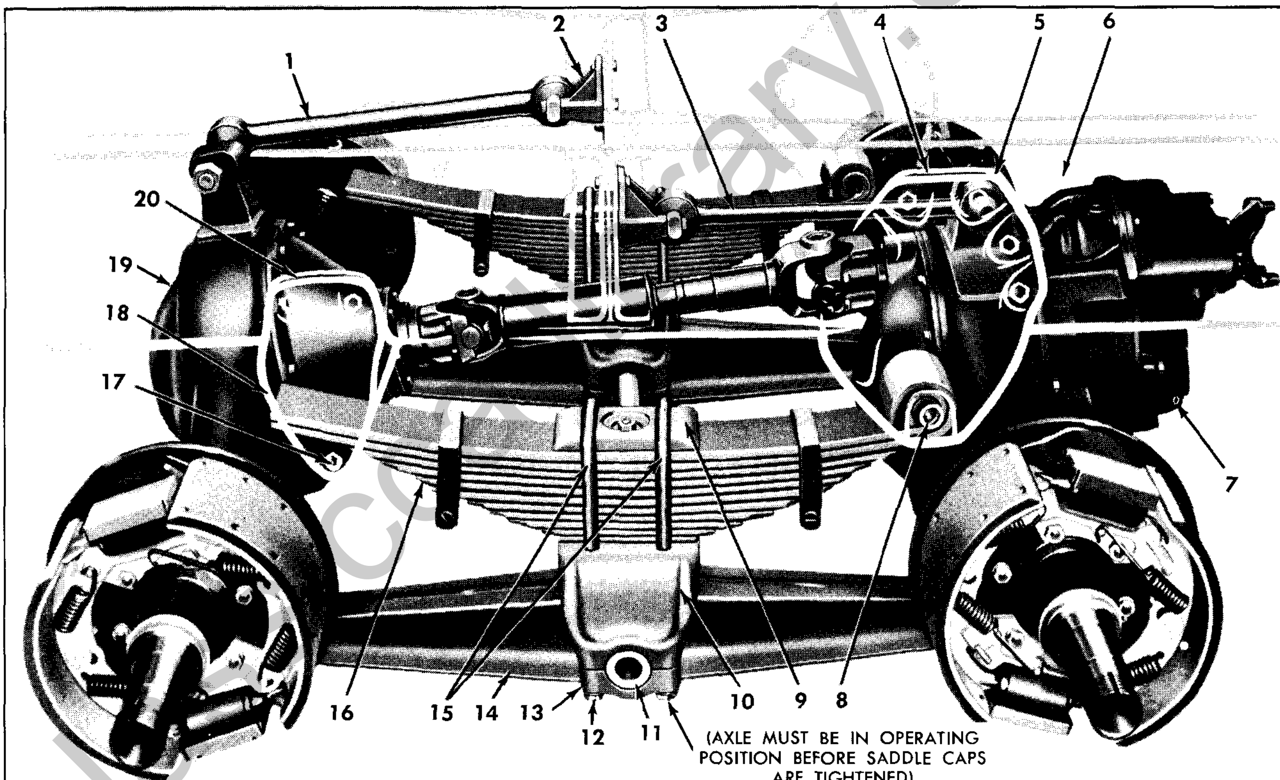
INSTALLATION RT AND RU TYPE

1. Roll axles and wheels, with equalizer beams and springs attached, in position under frame.

2. Lower frame as required to align spring front pin with bracket raise and support forward axle, then remove wheels. Install spring front pin through bracket and spring eye, with milled flat near end of pin aligned with lock bolt hole in bracket. Use a soft hammer to drive pin in.

3. Install spring front pin lock bolt and nut and tighten firmly. Install lubrication fitting in inner end of pin.

4. Install rebound bolt in rear bracket.



1 Torque Rod (Rear)
2 Torque Rod Bracket
3 Torque Rod (Front)
4 Spacer
5 Frame Bracket (Front)
6 Frame
7 Forward Rear Axle
8 Spring Eye Bushing
9 Top Pad
10 Spring Saddle
11 Beam Center Bushing
12 Cap Screws
13 Spring Saddle Cap
14 Equalizing Beam
15 Top Pad U-bolt
16 Spring Assembly
17 Rebound Bolt
18 Spring Bracket (Rear)
19 Rearward Rear Axle
20 Spacer

T-6820

Figure 9—Tandem Rear Axle Suspension (Hendrickson RU) (Typical)

5. Install torque rods to axle brackets.

NOTE: When tightening nuts, rap bracket with hammer to drive taper of torque rod stud into bracket. Tighten nut to torque listed in "Specifications" at end of this section.

6. Connect brake lines to each axle assembly; then connect propeller shaft and check drive line alignment as covered in "PROPELLER SHAFTS" (SEC. 4D) in this manual.

7. Install front duals, then remove supports from under axle.

8. Lubricate shackle pin at lube fitting.

NOTE: Care should be exercised to prevent axles from rolling and causing injury or damage to parts.

INSTALLATION - RS-380 TYPE
(Refer to Fig. 10)

1. Raise frame to supply sufficient clearance of suspension assembly under frame and cross-members.

2. Roll assembly complete with wheels, equalizer beams, cushion assembly, and hangers under frame.

3. Lower frame taking care to align suspension hanger bolt holes with bolt holes in frame. Use drift through holes if necessary. Rest frame on hangers.

4. Install the 28 side and lower hanger bolts, lock washers, and nuts. Torque nuts to 90 to 110 foot-pounds.

5. Install torque rods to axle brackets as described under "Torque Rods."

6. Connect brake lines to axles, and connect prop shaft to forward rear axle as described in "Propeller Shafts" (SEC. 4D) in this manual.

SPRING REPLACEMENT (RT AND RU MODELS)

REMOVAL (Refer to Figs. 8 and 9)

1. Remove duals from front and rear tandems to facilitate removal of spring eye pin if pin must be driven from bracket. Raise and support vehicle frame to remove load from springs.

2. Remove rebound bolt from bottom of spring rear bracket.

3. Remove lock bolt securing spring pin in front bracket. Remove lubrication fitting from inner end of pin, pin may be removed with slide hammer. In some cases it may be necessary to drive pin out with soft drift and hammer from outer side.

4. On vehicles equipped with the "RT" type suspension shown in figure 8, remove four bolts which attach spring saddle top pad to spring saddle; hold nuts at bottom while turning bolt at top. Loosen lock nuts on top pad setscrew, then loosen setscrew and lift top pad and then slide from top of spring.

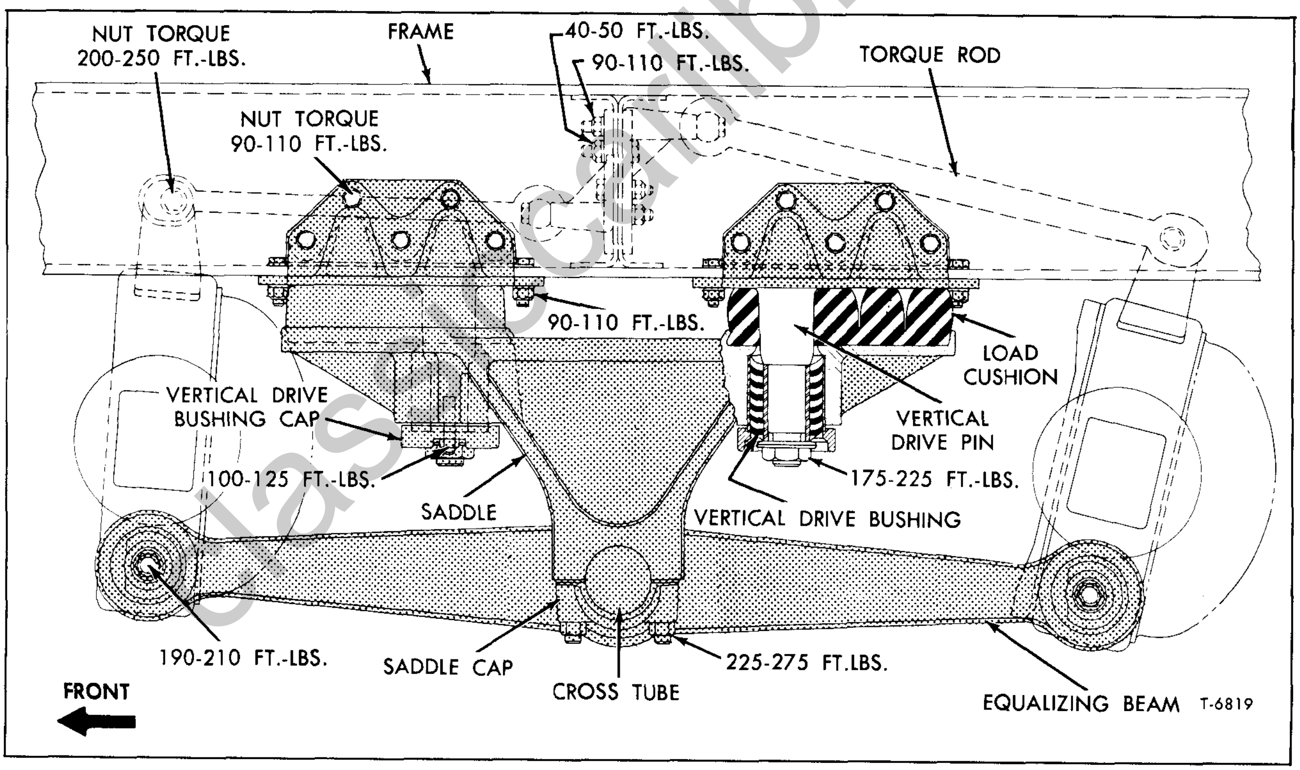


Figure 10—Tandem Rear Axle Suspension (Hendrickson RS-380)

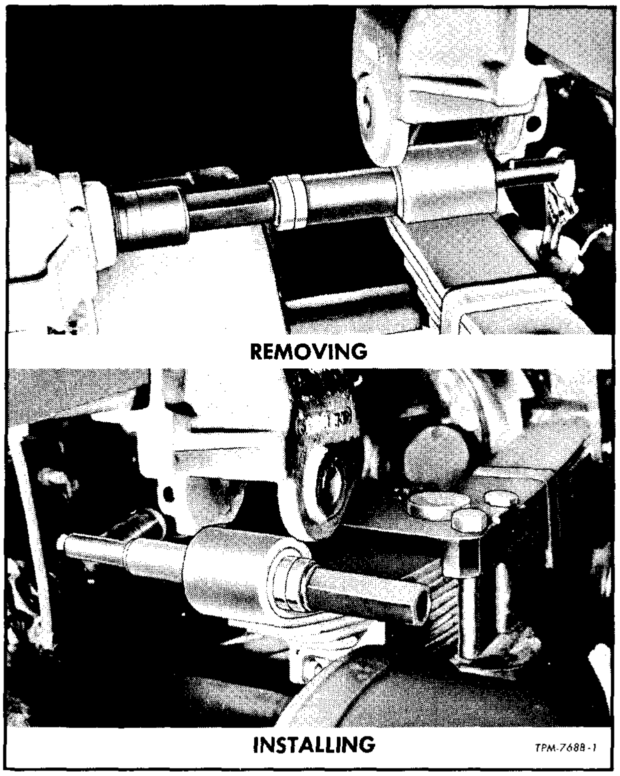


Figure 11—Tool Application for Replacing Spring Eye Bushing

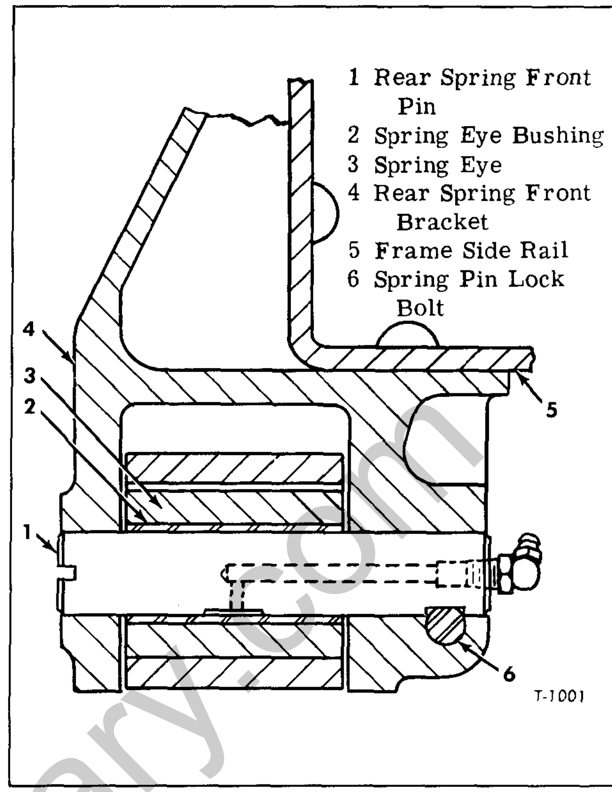


Figure 12—Section Through Spring Eye and Front Bracket (Typical)

Lift spring assembly up and rearward to remove from spring saddle.

5. On vehicles equipped with the "RU" type suspension shown in figure 9, remove bolts which attach spring saddle cap to saddle; then lift spring and saddle assembly up and rearward to remove. It may be necessary to raise frame higher for saddle to clear equalizer beam. Remove U-bolt nuts which attach top pad to saddle, then remove U-bolts, top pad, and saddle from spring.

INSPECTION OF SPRING

1. Thoroughly wash spring eye bushings and bracket pins to remove all old lubricant. Make sure lubricant passages in pins are open.

2. Insert pins into plain bushings in spring eyes and bracket and check for looseness. If excessive looseness is evident, pins and bushings must be replaced. Refer to "Replacing Radius Leaf Eye Bushing" earlier in this section for bushing replacement procedure. Figure 11 shows arrangement of tools for removing and installing spring eye bushing on tandem suspension.

3. Inspect spring assembly for broken leaves. No. 1 and No. 2 leaves can be replaced. If other leaves are broken, replace complete spring assembly. Replace broken leaves as directed later under "Repair."

4. Inspect spring for loose or broken rebound clips. Rebound clips should be tight enough to hold spring leaves in alignment, but not tight enough to restrict free movement of leaves.

5. Check for broken or loose spring center bolt. Replace or tighten as necessary.

6. Make sure machined surfaces of spring saddle are clean. Spring leaves must be free of rust and scale build-up if they are to be retained securely by U-bolts.

SPRING LEAF REPLACEMENT

1. Mark down one side of springs to assure original position of springs when assembling later, then place spring in a vise or arbor press, next to center bolt.

2. Remove nuts and bolts from spring rebound clips.

3. File off peened end of center bolt, then remove nut and bolt.

4. Release vise or arbor press slowly to avoid possible injury. Separate spring leaves and clean thoroughly, using a wire brush if necessary.

5. Replace any broken rebound clips.

6. Replace broken leaf and stack leaves in correct order, applying a thin film of graphite grease to each leaf. Align center bolt holes in spring leaves with long drift, then compress spring leaves in vise or arbor press.

7. Install center bolt and nut and tighten nut. Peen end of bolt to prevent nut loosening.

8. Remove spring from vise or arbor press. Align spring leaves by tapping with hammer; then install rebound clips, bolts, and nuts. Tighten enough to hold spring leaves in alignment, but not enough to restrict free movement of leaves.

INSTALLATION (WITH "RT" TYPE SUSPENSION (Fig. 8)

1. Position spring assembly on spring saddle with head of center bolt in locating hole in saddle and with spring ends in place in frame brackets.

2. Place top pad slide on top spring leaf, then position top pad over spring and saddle.

3. Install top pad to saddle bolts and nuts and tighten snugly. Tighten top pad setscrews to torque listed in "Specifications" at end of this section. Tighten setscrew lock nuts.

IMPORTANT: The top pad setscrews must be tightened to specified torque to properly seat spring against machined face of saddle before torquing top-pad-to-saddle bolts.

4. Tighten top-pad-to-saddle bolts to torque listed in "Specifications." Hold nuts at bottom while using torque wrench on bolt heads at top.

5. Install spring eye pin through bracket and spring eye, with milled flat near end of pin aligned with lock bolt hole in bracket. Use a soft hammer to drive pin in from outer side. Install spring front pin lock bolt and nut with washer and tighten firmly. Install lubrication fitting in inner end of eye pin. Figure 12 illustrates section through pin, spring eye, and frame bracket.

6. Install spring rebound bolt in lower end of rear frame bracket. Lubricate spring ends as directed in LUBRICATION (SEC. 0) in this manual. Remove support from under frame.

INSTALLATION (Fig. 9)
(WITH "RU" TYPE SUSPENSION)

NOTE: To obtain proper torque on top pad to spring saddle U-bolt nuts, assemble spring saddle and top pad to spring assembly prior to installing spring assembly in vehicle.

1. Position spring saddle on spring assembly with head of center bolt in locating hole in saddle.

2. Position top pad on spring assembly, then place U-bolts over top pad and through saddle assembly. Place nuts on U-bolts and tighten to 275-325 foot-pounds torque.

3. Position spring and saddle assembly over equalizer beam and install spring front pin through bracket and spring eye, with milled flat near end of pin aligned with lock bolt hole in bracket. Use a soft hammer to drive pin in from outer side.

4. Install spring front pin lock bolt and nut and tighten firmly. Install lubrication fitting.

5. Install rebound bolt in lower end of rear bracket. Lubricate spring ends as directed in LUBRICATION (SEC. 0) in this manual.

6. Position axles in operating position, then check to be sure spring saddle is properly positioned over equalizer beam and beam center bushing. Install spring bolts to torque listed in "Specifications" at end of this section. Remove support from under vehicle frame.

SADDLE REMOVAL AND REPAIR (RS 380 TYPE SUSPENSION)

SADDLE REMOVAL (Refer to Fig. 10)

1. Remove equalizing beams and cross tube as described under "Equalizing Beam Removal."

2. Support the saddle assembly from underneath to prevent damage or personal injury during removal of the vertical drive bushing caps.

3. Remove the vertical drive bushing caps, and remove the vertical drive pin nuts and flanged washers.

4. Remove saddle(s) and load cushions from vertical drive pins.

VERTICAL DRIVE BUSHING REPLACEMENT

1. Press old bushing out, using a suitable sleeve to exert force from the top of the saddle.

IMPORTANT: If the outer sleeve is frozen to the saddle wall, press the inner sleeve and rubber bushing out of the saddle and work the outer sleeve out of the saddle. Do not cut sleeve with torch or use heat as saddle is heat-treated.

2. Clean the bushing cavities in the saddles with solvent and remove any nicks with emery cloth.

3. Coat saddle cavities and outer sleeve of new vertical drive bushing with rust-proofing compound.

4. Install new bushing in saddle.

NOTE: This bushing is not a pressed fit and new bushings can be hand pressed.

LOAD CUSHIONS

Visual inspection will determine necessity for replacement. If the load cushion is cut or damaged, it will lose its load-carrying capacity and replacement should be made.

The free height (no load) of the load cushion is 3-15/16 inches and it is possible that a permanent set could result in service. Whenever a saddle(s) is removed from vehicle for any reason this free height should be checked. If a permanent set of nor more than 1/4-inch is noted, the cushion is still considered acceptable for re-use.

NOTE: This means that a load cushion with a free height of less than 3-11/16 inches should be replaced.

SADDLE INSTALLATION

1. Install the vertical drive bushing caps. Tighten nuts to 100-125 foot-pounds torque.

2. Position load cushions on saddle(s).

3. Support saddle assembly from underneath to prevent damage or personal injury during installation. Position saddle(s) on vertical drive pins and install flanged washers (flange down) and nuts. Tighten vertical drive pin nuts to 175-225 foot-pounds torque.

4. Install equalizing beams and cross tube as described later under "Equalizing Beam Installation."

EQUALIZING BEAM REMOVAL AND REPAIR (RT AND RU)

The following procedures cover removal and installation of either equalizing beam without removing any other units of the suspension system. When removing an axle assembly, accomplish only steps required to loosen axle at each end of beam.

EQUALIZING BEAM REMOVAL (Fig. 13)

1. Raise and support frame to remove weight from beams.

2. At axle brackets, remove nuts (5), washers (7), and bolt (1). Pry adapters (2) from bushings and brackets.

3. With blocking under beam cross tube (fig. 14 or 15) to support weight of beams, remove saddle caps (fig. 8 or 9) attached with four nuts and special flat washers.

4. Lower the cross tube and beams, then slide beams from tube ends.

EQUALIZING BEAM INSPECTION

1. Inspect beam end bushings and beam center bushing for evidence of damage or deterioration of the rubber. If any damage is evident, replace bushings as directed under "Equalizing Beam Bushing Replacement" later in this section.

2. Inspect cross tube and replace if bent or worn.

EQUALIZING BEAM BUSHING REPLACEMENT

Press old bushing out, using a suitable driver or press to exert force on bushing outer sleeve. Press new bushing into place, exerting force on bushing outer sleeve until outer sleeve extends an equal distance through beam at both sides.

EQUALIZING BEAM INSTALLATION
(Refer to Fig. 14 or 15)

1. Position beams, with cross tube in place at spring saddles (fig. 8 or 9) and axle brackets.

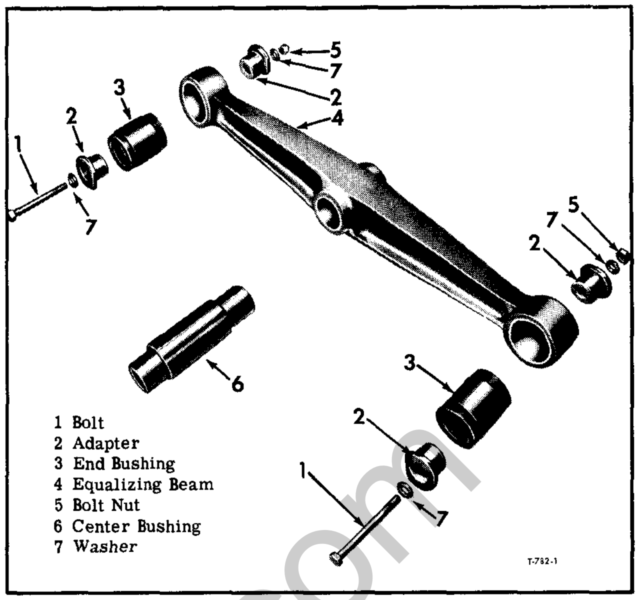


Figure 13—Equalizing Beam Components (Typical)

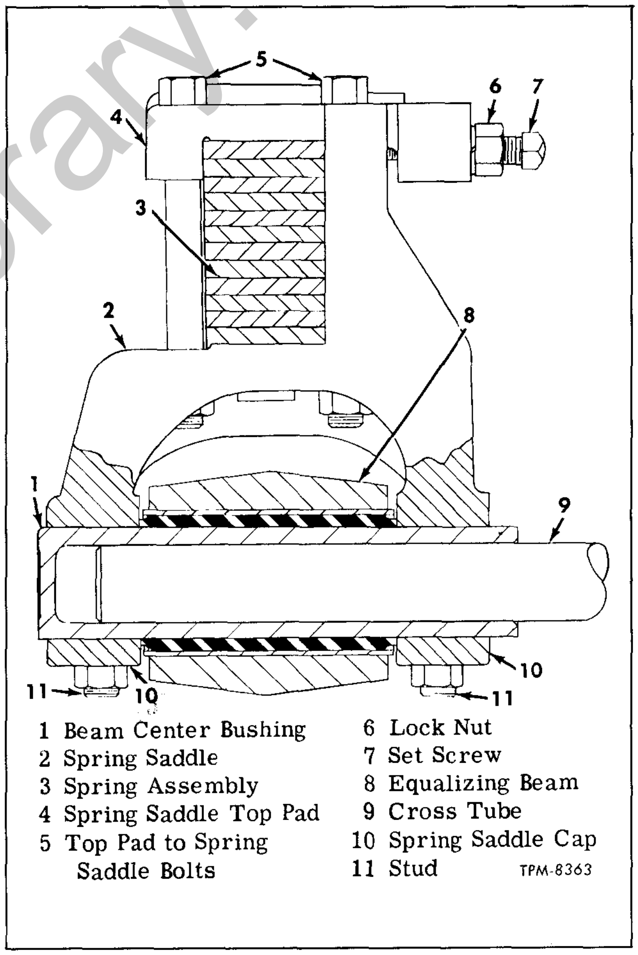


Figure 14—Section Through Spring Saddle and Beam (RT Type Suspension)

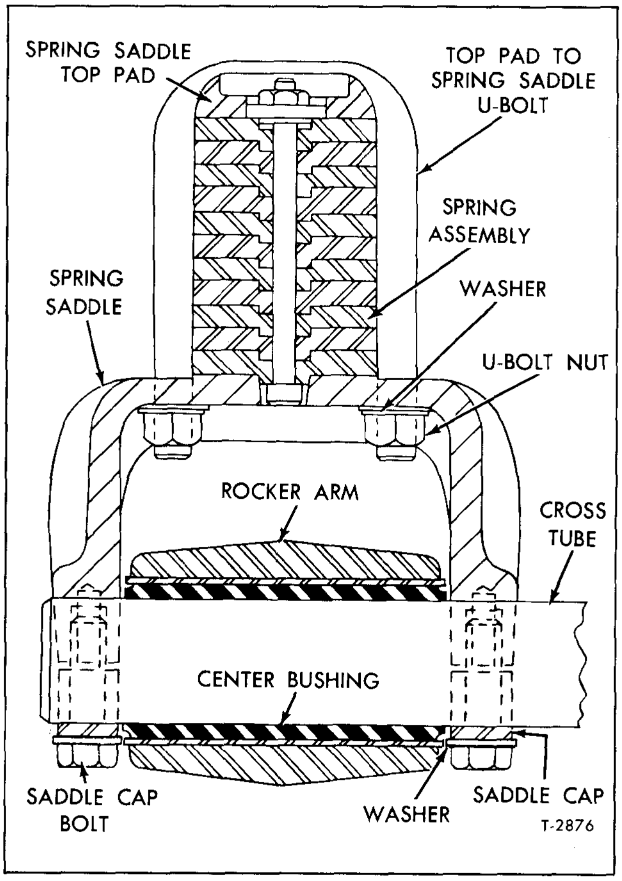


Figure 15—Section Through Spring Saddle and Beam (RU Type Suspension)

NOTE: At axle end of beam, install adapters (2, fig. 13) at each side of bracket and into bushing.

IMPORTANT: The cut-off (flat) side of each adapter must be located in a vertical position as shown in figure 16.

2. Install bolt and washer through adapter and axle bracket at each end of equalizing beam (fig. 16).

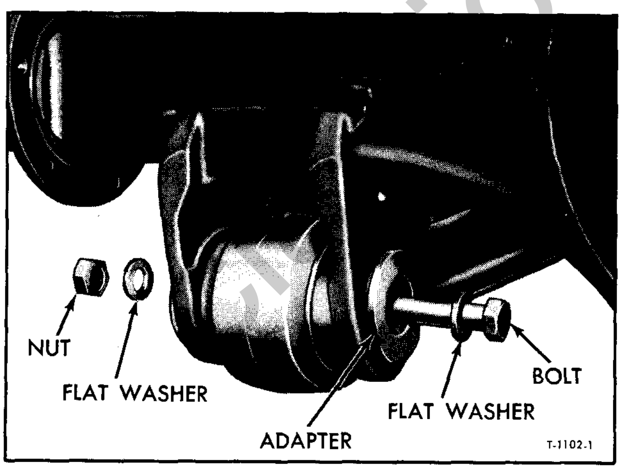


Figure 16—Adapter and Retaining Bolt at Axle Bracket

NOTE: Install bolt and washer from inner side with nut located toward wheels (fig. 16). Tighten nuts or bolts to torque listed in "Specifications" at end of this section. Figure 17 shows section through mounting.

3. Install spring saddle caps to attach beam center bushing to spring saddle. Install saddle cap stud nuts or cap screws and tighten to torque listed in "Specifications" at end of this section.

TORQUE RODS (ALL RT AND RU MODELS)

Solid type torque rods are used on all vehicles equipped with the tandem suspension system. The torque rods serve to maintain proper drive line angles and stabilize driving and braking forces.

NOTE: Refer to "PROPELLER SHAFTS" (SEC. 4D) for torque rod installation and drive line angle adjustment procedure.

TORQUE ROD REMOVAL

IMPORTANT: If torque rods are to be removed and ends replaced or repositioned, measure overall length of rod (center of ball stud seat at one end to center of ball stud seat at the other end) to assure installation of the same length rod.

1. At axle end, remove nut from torque rod end stud and drive end stud out of bracket on axle housing using a soft hammer.

2. At frame end, remove self-locking nuts from bolts attaching torque rod bracket to frame crossmember. Note the number and position of shims or spacers (if used) between bracket and frame member, then remove torque rod and frame bracket assembly.

IMPORTANT: Shims and spacers are used on vehicles equipped with front and rear torque rods to maintain drive line alignment.

3. Clamp torque rod bracket in vise, remove nut from torque rod end stud, then drive stud out of bracket with soft hammer and driver.

TORQUE ROD INSPECTION

Examine ball studs for damaged threads and for looseness in rubber bushings in torque rod ends. If any damage or deterioration of the rubber is evident, the complete torque rod assembly must be replaced.

Inspect taper surfaces on torque rod end studs. Check tapered hole in frame and axle brackets for wear by checking fit of new torque rod end stud in hole. Replace bracket if looseness is evident. Remove all burrs, grease, paint, or other foreign material from the hole or stud taper before installing.

TORQUE ROD INSTALLATION

1. Install torque rod bracket on frame crossmember.

IMPORTANT: It is essential to use same number of spacers or shims as previously used to assure original drive line alignment.

2. Install torque rod with end studs inserted through brackets at axle and at crossmember. Install nut and washer on each end stud. With weight of unloaded vehicle on suspension, tighten torque rod end stud nuts firmly. Strike ball end of each end stud a sharp blow with hammer to assure seating of tapers.

PAGE AND PAGE LIGHT WEIGHT HUSKY REAR SUSPENSION

On steel and aluminum tilt cab models, driving and braking forces are transmitted to the vehicle chassis through solid front and rear torque rods and rocker arms. Inverted springs are center mounted to the cross tube with spring eyes rubber encased in cup-shaped retainers.

The torque rods are positioned to maintain proper drive line alignment as well as to stabilize driving and braking forces. Figure 18 shows a typical arrangement of suspension system units. Rubber mounts and bushings are used at all pivot points including torque rod ball studs.

When a major overhaul is required, the complete tandem unit should be removed from the frame; however, torque rods, springs, rocker arms, and other components may be removed separately as required. Vehicle should be safely blocked to prevent rolling before starting work.

TANDEM UNIT REPLACEMENT

TANDEM UNIT REMOVAL

1. Block wheels on both axles and disconnect brake lines from axles.
2. Disconnect propeller shaft from forward rear axle as explained in "PROPELLER SHAFTS" (SEC. 4D).
3. Support frame securely and remove bolts which attach pedestal to cross tube or frame.
4. On all models, note number of shims between torque rod brackets and bogie crossmember. to insure same dimension at installation. At each axle end, remove nut from torque rod end stud and drive end stud out of axle bracket using a soft hammer.
5. Check to make sure all lines have been disconnected from axle, then using a suitable hoist, raise rear end of frame and roll axles, with rocker arms cross tube and springs, out from under frame.

TANDEM UNIT INSTALLATION

1. Roll axles and wheels, with rocker arms cross tube, and springs attached, in position under frame.
2. Lower frame as required to align pedestal with cross tube or frame and install pedestal to cross tube or frame bolts and tighten to torque listed in "Specifications" at end of this section.
3. Install torque rods to axle bracket.

NOTE: When tightening torque rod stud nuts, rap bracket with hammer to drive taper of torque rod stud into bracket. Tighten nut to torque listed in "Specifications" at end of this section.

4. Connect brake lines to each axle assembly, then connect propeller shaft and check drive line alignment as covered in "PROPELLER SHAFTS" (SEC. 4D).

SPRING REPLACEMENT

SPRING REMOVAL (Fig. 18)

1. Raise vehicle frame to remove load from spring. Support frame securely.
2. Remove cross tube to spring cap U-bolt

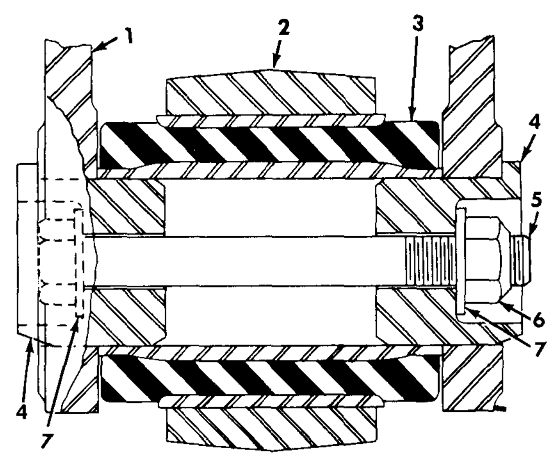


Figure 17—Equalizing Beam Mounting at Axle Bracket

nuts and remove spring cap from spring.

3. Remove nuts from insulator cap to rocker arm U-bolts, then remove insulator cap and insulator (inset, fig. 19).

4. Lift spring and remove from rocker arm.

SPRING INSTALLATION (Fig. 18)

NOTE: Before installing spring assembly in vehicle, inspect rubber insulator and spring cam for excessive wear or damage.

1. Position spring assembly on rocker arm with spring eye engaging insulator and cam as shown in Inset, figure 20.

2. Position insulator cap over spring eye, insulator, and spring cam; then install insulator cap to rocker arm U-bolt. Tighten U-bolt nuts firmly.

3. Position spring cap on spring assembly with head of center bolt in locating hole in spring cap. Install U-bolts over bracket on cross tube and attach to spring cap with nuts and washers. Tighten nuts to torque listed in "Specifications" at end of this section.

4. Tighten insulator cap to rocker arm U-bolt nuts to torque listed in "Specifications" at end of this section. Remove support from under frame.

ROCKER ARM (PAGE AND PAGE LWH)

ROCKER ARM REMOVAL (Fig. 19)

1. Safely support axles, then remove wheels.

2. Raise and support frame to remove weight from rocker arms.

3. With cross tube and rocker arm safely supported, remove nuts and lock washers from spring cap. Remove spring cap and cross tube to spring cap U-bolts.

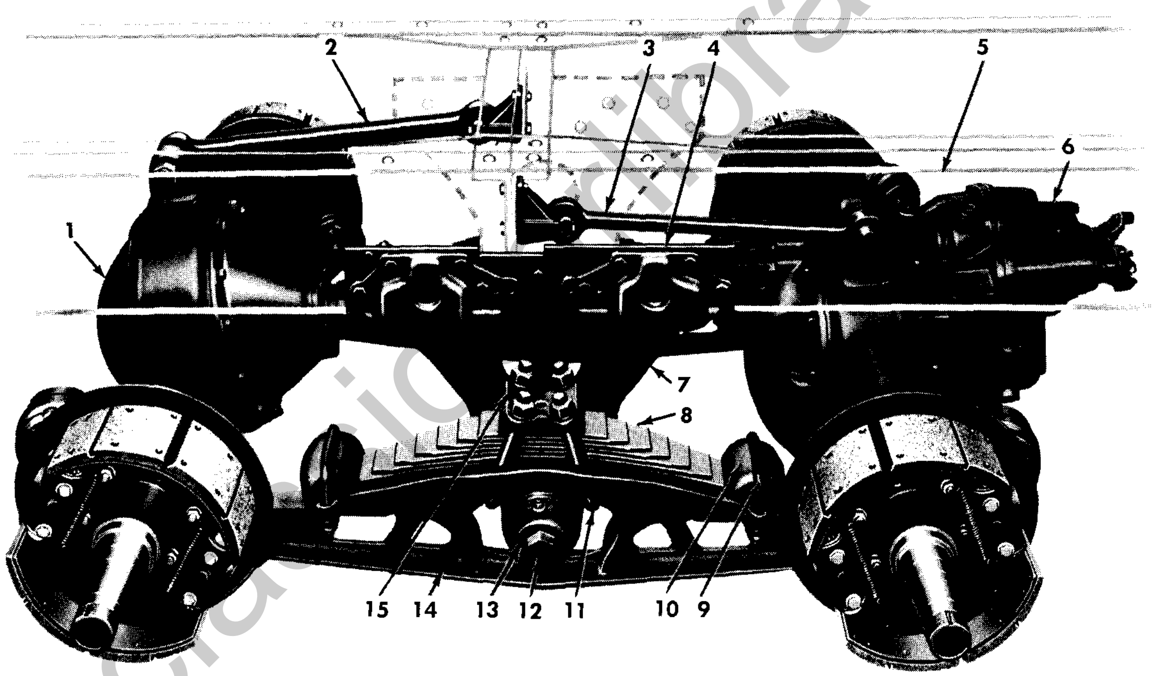
4. At axle brackets, remove nuts, washers, and bolt. Pry adapters from bushings and brackets.

5. Lower the cross tube and rocker arm, then slide the rocker arm from end of cross tube.

ROCKER ARM INSPECTION (Fig. 19)

1. Inspect rocker arm end bushings for evidence of damage or deterioration of the rubber. If damage or deterioration is evident, replace bushings as directed later under "Rocker Arm Bushing Replacement."

2. Inspect cross tube bushings (Inset, fig. 19) for evidence of damage or deterioration of rubber. If damage is evident, replace bushing as directed



1 Rearward Rear Axle
2 Rear Torque Rod
3 Front Torque Rod
4 Pedestal Spacer
5 Frame
6 Forward Rear Axle
7 Pedestal
8 Spring
9 U-bolt
10 Insulator Cap
11 Spring U-bolt
12 Bolt
13 Compression Cap
14 Rocker Arm
15 Spring Cap

Figure 18—Page and Page (LWH) Rear Suspension Installed (Typical)

later under "Cross Tube Center Bushing Replacement."

ROCKER ARM BUSHING REPLACEMENT

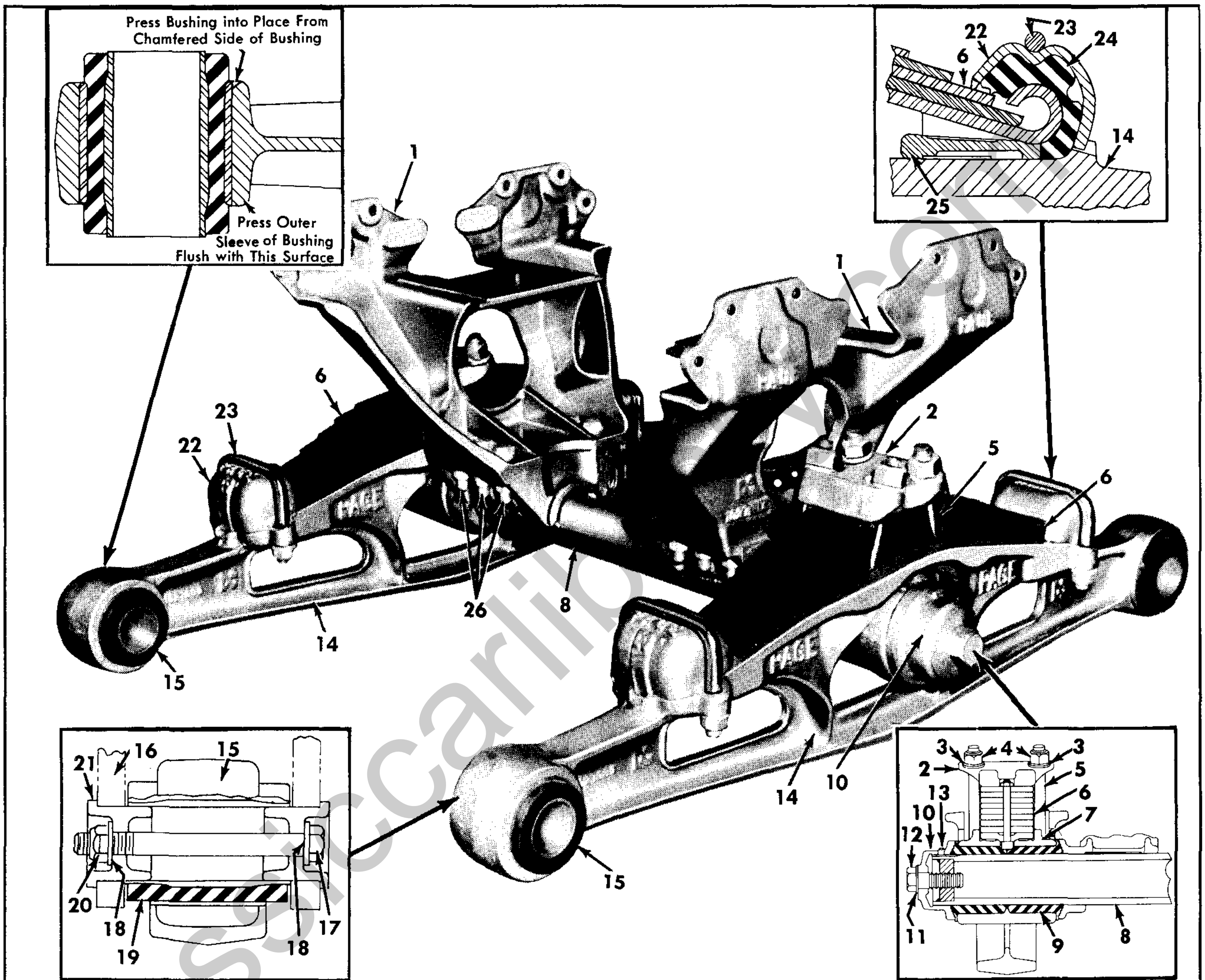
Press old bushing out, using a suitable driver to exert force on bushing outer sleeve. Press new bushing into place, exerting force on bushing outer sleeve until outer sleeve extends an equal distance through rocker arm at both sides.

CROSS TUBE CENTER BUSHING REPLACEMENT (Inset, Fig. 19)

1. Remove dowel pin, bolt and washer retaining compression cap to trunnion tube. Remove compression cap.

2. Using a suitable tool, remove rubber bushing from trunnion mount.

3. Thoroughly coat the rubber bushings, trunnion mount, and tube with brake fluid, then insert



1 Pedestal
2 Spring Cap
3 Washer (Spring Cap)
4 Nut (Spring Cap)
5 Cross Tube to Spring Cap U-bolt
6 Spring Assembly
7 Trunnion Mount
8 Cross Tube
9 Bushing
10 Compression Cap
11 Compression Cap Washer
12 Compression Cap Bolt
13 Dowel Pin
14 Rocker Arm Assembly
15 Rocker Arm Bushing
16 Axle Bracket
17 Adapter Bolt
18 Washer
19 Bushing
20 Nut
21 Adapter
22 Insulator Cap
23 Insulator Cap U-bolt
24 Insulator Spring
25 Spring Cam
26 Pedestal to Cross Tube Nut

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Figure 19—Page and Page (LWH) Rear Suspension Removed (Typical)

rubber bushings into trunnion mount until bushings seat against spacer located at center of the trunnion mount bore. Slide trunnion mount assembly onto trunnion tube using a rocking motion. Rotate assembly until dowel pin engages slot in compression tube. Install dowel pin.

4. Tighten compression cap bolt until exposed rubber measures 0.045 to 0.125 inches on both ends.

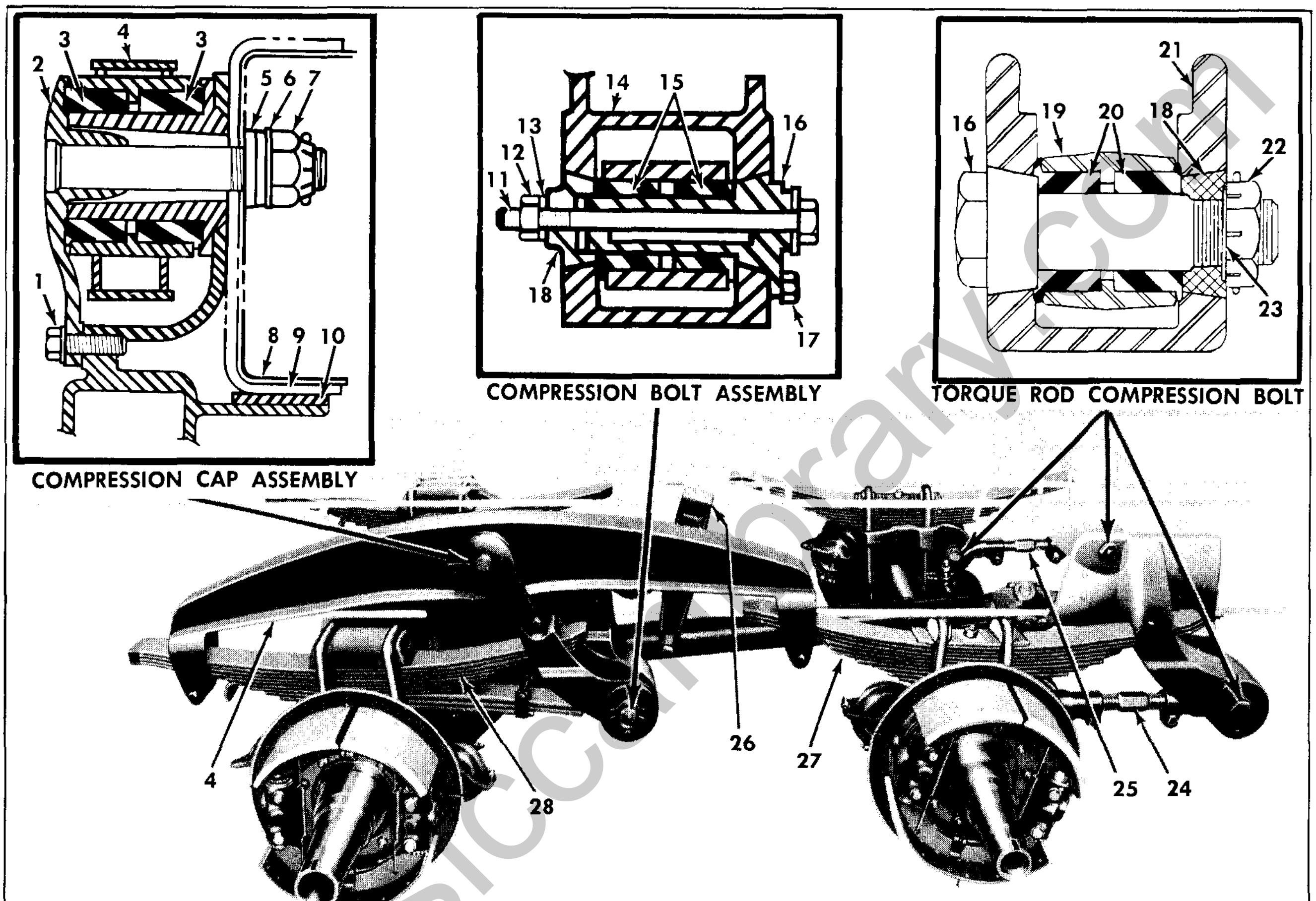
NOTE: A minimum of 500 foot-pounds torque should be required to displace the rubber bushings to dimensions listed above. If less than 500 foot-pounds torque is required, disassemble and place rubber spacer rings against the hub spacer ring and reassemble.

ROCKER ARM INSTALLATION (Fig. 19)

1. Place rocker arm in position at axle brackets making certain cross tube is entered in rocker arm center opening. Install adapters at each side of axle brackets and into rocker arm bushings.

2. At each end of rocker arm, install bolt with flat washer through axle bracket and rocker arm.

NOTE: Bolt should be installed from inner side with nut located toward the wheel. Tighten



PAGE AND PAGE SUSPENSION SYSTEM

1 Compression Cap Bolt
2 Compression Cap Assembly
3 Rubber Bushing
4 Rocker Arm
5 Backing Washer
6 Thrust Washer
7 Compression Cap Lock Nut
8 Frame Reinforcement
9 Frame
10 Frame Rear Spring Rear Hanger Spacer
11 Compression Bolt Retaining Bolt
12 Compression Bolt Retaining Bolt Nut
13 Compression Bolt Retaining Bolt Nut Washer
14 Rocker Arm Bracket
15 Rubber Bushing
16 Compression Bolt
17 Compression Bolt Lock Bolt
18 Compression Washer
19 Torque Rod
20 Rubber Bushing
21 Front Spring Hanger
22 Compression Bolt Lock Nut
23 Brass Washer
24 Torque Rod (Adjustable)
25 Torque Rod (Adjustable)
26 Rocker Arm Stop
27 Spring (Front Unit)
28 Spring (Rear Unit)

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Figure 20—Page and Page 800 Tandem Suspension

nuts or bolts to torque listed in "Specifications."

3. Position spring cap on spring assembly with head of center bolt in locating hole in spring cap; then place U-bolts over cross tube bracket and through spring cap. Install lock washers and nuts and tighten to torque listed in "Specifications" at end of this section.

4. Install wheels, then lower vehicle.

TORQUE RODS

Information pertaining to torque rod removal and installation remains the same as covered under "Torque Rods" at end of "Hendrickson Tandem Rear Suspension" section previously.

NOTE: Refer to "PROPELLER SHAFTS" (SEC. 4D) for torque rod and drive line angle adjustment.

PAGE AND PAGE 800 SUSPENSION

STANDARD MODEL ILLUSTRATED (Fig. 20)

Driving torque and braking forces are transmitted directly to the frame through torque rods at front axle unit and radius leaves at rear axle unit.

Through a rocker arm, torque rod, and radius leaf arrangement, the weight imposed upon the rear axle is equally distributed between the two axle units as shown in figure 20. All pivot-points are rubber bushed. Torque rods are solid type.

The rear axle unit is equipped with adjustable eccentric compression bolts which attach the rear spring radius leaves to the rocker arm bracket assembly.

SPRINGS

REMOVAL (FRONT UNIT)
(Refer to Fig. 20)

1. Block front wheels to prevent vehicle from rolling. Jack up frame until tension and weight are removed from springs. Block frame securely.
2. Remove nuts and washers from spring U-bolts, then remove U-bolts, U-bolt spacer, and U-bolt axle clamp.
3. Remove bolt nut, bolt, and rebound roller from rocker arm.
4. Move spring assembly rearward and remove from vehicle.

REMOVAL (REAR UNIT)
(Refer to Fig. 20)

1. Block front wheels to prevent vehicle from rolling, Jack up frame until tension and weight are removed from springs. Block frame securely.
2. Remove nuts and washers from spring U-bolts, then remove anchor plate, U-bolts and U-bolt spacer.
3. Remove bolt nut, bolt, and rebound roller from rocker arm.
4. At spring eye, remove compression bolt, lock bolt, retaining bolt nut, flat washer, and retaining bolt.
5. Using suitable tools, pry compression bolt out of spring eye, then remove compression washer at inside of frame.
6. Remove spring assembly from vehicle.

SPRING DISASSEMBLY

1. Mark down one side of springs to assure original position of leaves when assembling later, then place spring in a vise or arbor press next to center bolt.
2. On rear spring, remove nut, bolt, and spacer from spring clip.
3. Remove spring center bolt. Release vise or arbor press slowly to avoid possible injury.

CLEANING, INSPECTION, AND REPAIR

1. Clean all rust and dirt from spring leaves, using a wire brush or scraper.
2. Inspect leaves for cracks or breaks. The Nos. 1, 2, and 3 leaves on front and Nos. 1, 2, and 3 main leaves and radius leaves Nos. 1 and 2 on rear can be replaced. If other than these leaves are broken, the complete spring assembly must be replaced.
3. Inspect radius leaf rubber bushings. If bushings are worn or deteriorated, replace.

ASSEMBLY OF SPRING

1. Stack spring leaves in correct order, then compress leaves with vise or arbor press.
2. On rear spring, radius leaves, install spring clip spacer, clip bolt, and nut. Tighten nut firmly.
3. Install center bolt and nut. Tighten nut firmly, then release vise or arbor press.

INSTALLATION (FRONT UNIT)
(Refer to Fig. 20)

1. Place spring assembly on spring seat, making sure ends of spring assembly are properly positioned and that center bolt enters locating hole in spring seat.
2. Position rebound rubber roller in rocker arm, then install bolt and nut. Tighten nut to 100-120 foot-pounds torque.
3. Place U-bolt spacer on top of spring, then install U-bolts.
4. Install U-bolt axle clamp and U-bolt washers and nuts. Tighten nuts to torque listed in "Torque Specifications" at end of this section under "Page and Page 800 Suspension System."
5. Remove blocks and jacks from under frame.

INSTALLATION (REAR UNIT)
(Refer to Fig. 20)

1. Place spring assembly on spring seat, making sure ends of spring assembly are properly positioned and that center bolt enters locating hole in spring seat.
2. Install compression bolt through rocker arm bracket and spring eye.
3. Referring to center inset in figure 20, install compression bolt, retaining bolt, compression washer, retaining bolt flat washer and nut. Align center tabs on outer end of compression bolt with lock bolt hole in bracket, then install compession bolt lock bolt. Do not final tighten nuts and bolts at this time.
4. Position rebound rubber roller in rocker arm, then install bolt and nut. Tighten nut to 100-120 foot-pounds torque.
5. With spacer on spring, install U-bolts.
6. Install U-bolt anchor plate, U-bolt flat washers, and nuts. Tighten nuts to torque listed in "Torque Specifications" at end of this section under "Page and Page 800 Suspension System."

IMPORTANT: Final tighten compression bolt retaining bolt nut and compression bolt lock bolt **to torque listed** in "Torque Specifications" at end of this section, only after the proper axle-to-frame alignment has been obtained.

7. Remove blocks and jacks from under the frame.
8. Check tandem alignment and adjust, if necessary, as directed under "Tandem Alignment" later in this section.
9. Finish tightening compression bolt lock bolt to proper torque.

ROCKER ARM (PAGE AND PAGE 800)

ROCKER ARM REMOVAL (Item 4, Fig. 20)

1. To facilitate removal of rocker arm, raise front and rear axles, safely support underneath and remove wheels.
2. Remove cotter pin, cap stud nut, cap stud thrust washer, and cap stud backing washers from compression cap and stud assembly.
3. Remove compression cap-to-frame bracket bolt and lock washer.
4. Remove compression cap and stud assembly from rocker arm and frame.
5. At each end of rocker arm, remove rebound bolt, nut, and rebound roller from spring holder bracket.
6. Raise frame until rocker arm end brackets clear ends of front and rear springs. Support frame securely.
7. Remove rocker arm by pulling straight off hanger pivot pin.

CLEANING, INSPECTION, AND REPAIR

1. Inspect rocker arm. If broken or cracked, replace rocker arm.
2. Inspect compression cap and stud assembly. If cracked or broken, replace cap assembly.
3. Inspect rocker arm rubber bushings. If bushings are worn or deteriorated, replace.
4. Inspect rocker arm stop (26, fig. 20) attached to frame. If broken or cracked, replace.

ROCKER ARM INSTALLATION
(Item 4, Fig. 20)

1. Position rocker arm with rubber bushings in place on frame bracket.
2. Position compression cap and stud assembly through rocker arm and frame bracket.
3. Install compression cap and stud to frame bracket lock washer and bolt. Do not tighten bolt at this time.
4. Install backing washers, thrust washer, and cap stud nut. Tighten nut firmly, then install cotter pin.
5. Now tighten compression cap and stud to frame bracket bolt to torque listed in "Torque Specifications" at end of this section.
6. Lower frame and rocker arm until ends of front and rear springs rest against cams of rocker arm spring holder brackets.
7. Install rebound bolts, nuts, and rebound rollers to rocker arm spring holder brackets. Tighten nuts to 100-120 foot-pounds torque.
8. Replace wheels at front and rear axles as directed in WHEELS AND TIRES (SEC. 10) in this manual.
9. Remove supports from axles and frame and safely lower to normal position. Inspect completed job for possible defects.

TORQUE RODS (FRONT UNIT) (PAGE AND PAGE 800)

REMOVAL (Fig. 20)

The procedure for removing the torque rods is as follows:

1. Remove cotter pins, nuts, compression washer, and brass washer from both ends of torque rod.
2. Drive compression bolts with collars out of spring frame hanger at front and axle spring seat at rear with a soft hammer.

INSPECTION

1. Inspect torque rods for cracks, bent condition, or damaged threads. Replace with new part if damaged in any way.
2. Inspect rubber bushings for deterioration. Replace if necessary.

3. Inspect compression washers, thrust washer, and compression bolt and collar assembly for wear or damage. Replace as needed if wear or damage is evident.

INSTALLATION (Fig. 20)

1. Position torque rods at spring frame hanger and axle spring seat.
2. Install compression bolt and collar assemblies from outside through spring seat, spring hanger, and torque rod assembly.
3. Position tapered compression washers over inner ends of compression bolt assemblies.
4. Place brass washer on inner ends of compression bolt assemblies. Install slotted nuts and tighten firmly. Tap head of bolt to seat compression washers, recheck tightness of nuts, then install cotter pins.
5. Check tandem alignment and adjust, if necessary, as directed under "Tandem Alignment" following:

TANDEM ALIGNMENT

Tandem rear axle misalignment may be due to improper number of torque rod shims, loose spring U-bolts, worn torque rod ends, loose bolts, or elongated holes in spring hanger or spring seat. If excessive tire wear occurs when it is apparent that the condition is not caused by tire operation or inadequate maintenance of the tandem unit, and after replacement of torque rods and springs, the axles should be checked for alignment. Check rear axle alignment with axle center lines at right angles to frame. Check forward axle and make sure that axle is parallel to the rear axle. Dimension between axle centers should not vary more than one-quarter-inch between either side. If the measurements show axles to be misaligned, it will be necessary to adjust alignment as follows:

REAR AXLE UNIT ADJUSTMENT
(Refer to Fig. 20)

1. Remove compression bolt lock nut (17). Loosen compression bolt retaining bolt (11).
2. Using a spanner wrench or a punch and hammer, rotate eccentric compression bolt. High side of eccentric is adjacent to the center tabs. By turning compression bolt clockwise, unit will move to the rear, and by turning compression bolt counterclockwise, unit will move forward. One-half inch spacing, forward or rearward may be obtained with this adjustment. A full one-quarter turn adjustment must be made to align locking tabs with lock bolt hole. Turn one or both compression bolts as required to position the axle at right angle to the frame.
3. Install compression bolt lock bolt (17), then tighten compression bolt retaining bolt and lock bolt, referring to "Torque Specifications" below:

FRONT AXLE UNIT ADJUSTMENT

1. Loosen dog-point lock bolt in one of the adjustable torque rod ends. Loosen clamp bolts in both ends of adjustable torque rod.
2. Turn threaded torque rod center to lengthen or shorten torque rod until the forward axle is parallel to the rear axle.

NOTE: If the rear axle is aligned properly, the forward axle will be at right angle to the frame also.

3. When correctly adjusted, tighten dog-point lock bolt and torque rod end clamp bolts firmly. Bend up tab of the lock washer under lock bolt.

REYCO TANDEM REAR SUSPENSION

DESCRIPTION AND OPERATION

The Reyco tandem suspension utilizes two full floating vari-rate leaf type springs at each side of vehicle frame. These springs are supported, and retained in place by three frame mounted hanger brackets, two of which serve as mounts for the spring radius leaf rod eye, while the third furnishes support for rear spring end. The center hanger bracket is of two-piece construction, and supports one end of each tandem spring. The two pieces are pivotally-fastened together in a manner which permits movement of the individual springs as they adjust to varying loads and changing road contour. The vehicle load is equalized through the leveling action of this pivoting bracket.

Driving and braking forces are transmitted to the vehicle frame by means of radius leaf rods, which are an integral part of the spring assembly. Eccentric type bushings are provided at each radius leaf eye, to permit alignment adjustment of each axle independently of each other. Total adjustment of 1-inch can be made at each axle.

Road shock is held to a minimum by rubber bushings and cushions at most points of movement, and lubrication of suspension is not necessary. The front end of each spring has a formed hook which catches on rebound bolt to prevent excess rearward movement of axle in the event of a broken radius leaf.

SPRING REPLACEMENT

REMOVAL - FRONT OR REAR

1. Raise vehicle frame until all weight is off spring ends. Safely support frame.
2. Remove U-bolt nuts, and washers, lower U-bolt spacer plate, U-bolts, and upper U-bolt spacer pad.
3. Remove front rebound bolt, nut, washer, and sleeve from front hanger.
4. Remove radius leaf eye bolt nut. At inner side of bracket, and using a suitable punch, drive eye bolt from bracket. Remove large flat washers.
5. Radius leaf eye bushing is a two-piece unit. Insert a punch to inside of bushing and drive one-half of bushing out. Repeat operation from opposite side to remove remaining half of bushing.
6. Raise frame to sufficient height to allow spring ends to clear hangers. Slide spring back and forth until removal of spring can be completed.

SPRING DISASSEMBLY

1. Scribe a mark down side of spring pile so spring can be re-assembled in same relative position.
2. Install a large C-clamp adjacent to center bolt with jaws of clamp at top and bottom of spring pile. Tighten clamp firmly.
3. Remove bolts, nuts, and sleeve from spring clips. Observe spring leaves, and especially top three leaves, as spring can easily be incorrectly assembled even though reference marks are used.
4. File peened end of center bolt if necessary, so nut can be removed. Remove nut and center bolt. Slowly release tension on C-clamp to free spring leaves.

NOTE: Disassembly procedure is the same for front or rear spring since springs are identical as shown in figure 21.

CLEANING, INSPECTION, AND REPAIR - ALL SUSPENSION COMPONENTS

Thoroughly wash spring leaves, eye bushings, and all component parts in a suitable solvent. Carefully inspect all spring leaves for breaks, and minute cracks. If any are found leaf should be replaced. Remove any scale, rust, or deposits which may have accumulated on leaves.

Inspect center bolt for distortion and wear. Replace bolt if not in perfect condition. All new bushings should be used, if any wear, deterioration, or distortion exists. Inspect the U-bolts and spring spacer plates, replace if damaged or cracked. Inspect hanger brackets at re-inforcing webbs, and in corners of casting. Do not weld or braze cracks. If casting is cracked it should be replaced.

Center hanger pivot arm bushing, can be replaced using conventional methods and equipment. All components which are secured with bolts and nuts, should be torqued to correct specification, listed in "Specifications" at end of this section.

ASSEMBLY OF SPRING

1. Stack spring leaves in correct order using

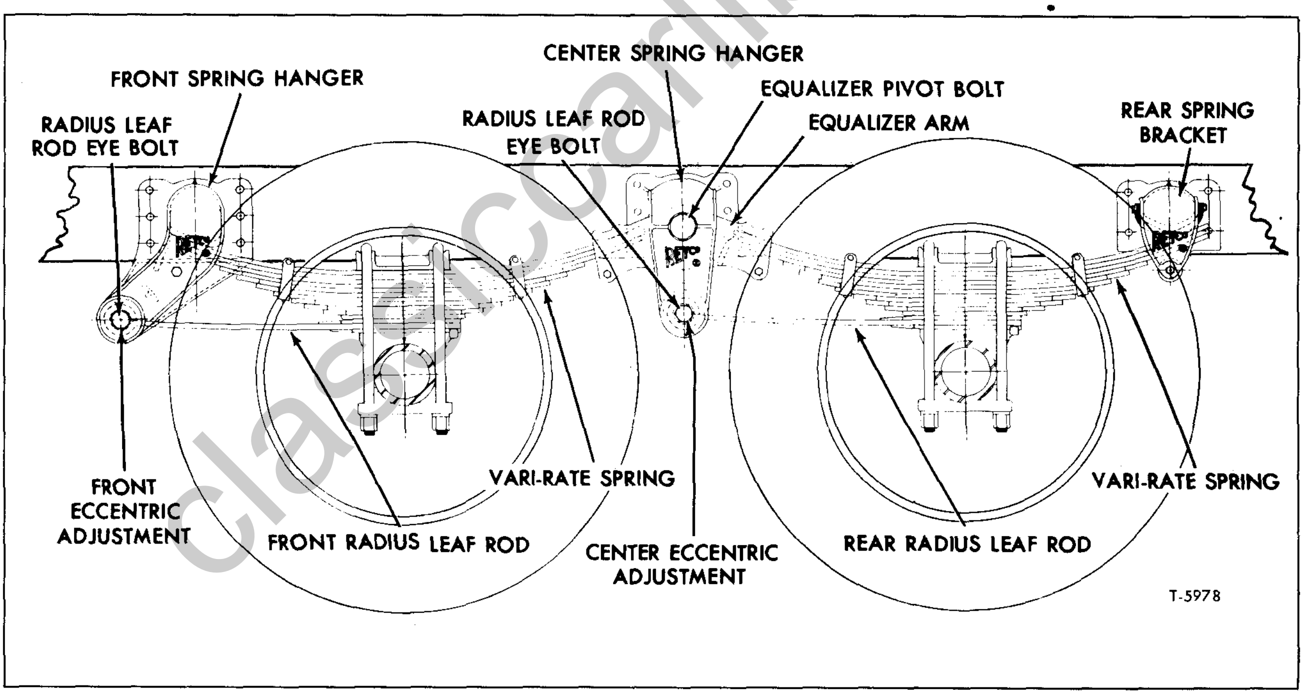


Figure 21—Reyco 101 Suspension

care to position leaves in proper sequence.

2. Align center bolt holes using a long punch or suitable tool. Place C-clamp jaws at top and bottom of spring pile, adjacent to center bolt and tighten clamp securely. Remove drift tool.

3. Install center bolt and nut. Tighten nut firmly and peen end of bolt to lock nut in place.

4. Install bolts, nuts, and spacer sleeves to spring clips, and tighten nuts firmly, peen ends of bolts if desired. Remove C-clamp.

SPRING INSTALLATION

1. Place spring assembly on axle spring seat, with ends of spring inserted in hanger openings, and center bolt head in locating hole of lower spring seat.

2. Place upper U-bolt spacer plate on top of spring and install U-bolts, and lower U-bolt spacer plate. Install U-bolt washers, and nuts, tighten nuts to correct torque of 300 foot-pounds.

3. Carefully lower frame until radius rod leaf eye is lined up with opening in spring hanger bracket.

4. Insert both halves of radius leaf eye bushing into spring hanger, and radius leaf eye opening. Lubricant such as neutral vegetable oil soap may be used if necessary to aid in pressing bushings in place.

5. Insert radius leaf eye bolt, and large flat washer through eye bolt opening. Install remaining flat washer and nut to eye bolt. Tighten nut to torque of 200 foot-pounds.

6. Install rebound bolt, sleeve, lock washer, and nut to hanger bracket. Tighten nut firmly.

7. Check axle to frame alignment as detailed later in this section under heading "Alignment Adjustment of Axle to Frame." Adjust axle alignment if necessary. Remove frame supports, lower jacks, and remove from vehicle.

ALIGNMENT ADJUSTMENT OF AXLE TO FRAME

If axle is suspected to be out of alignment, the following procedure must be followed to inspect,

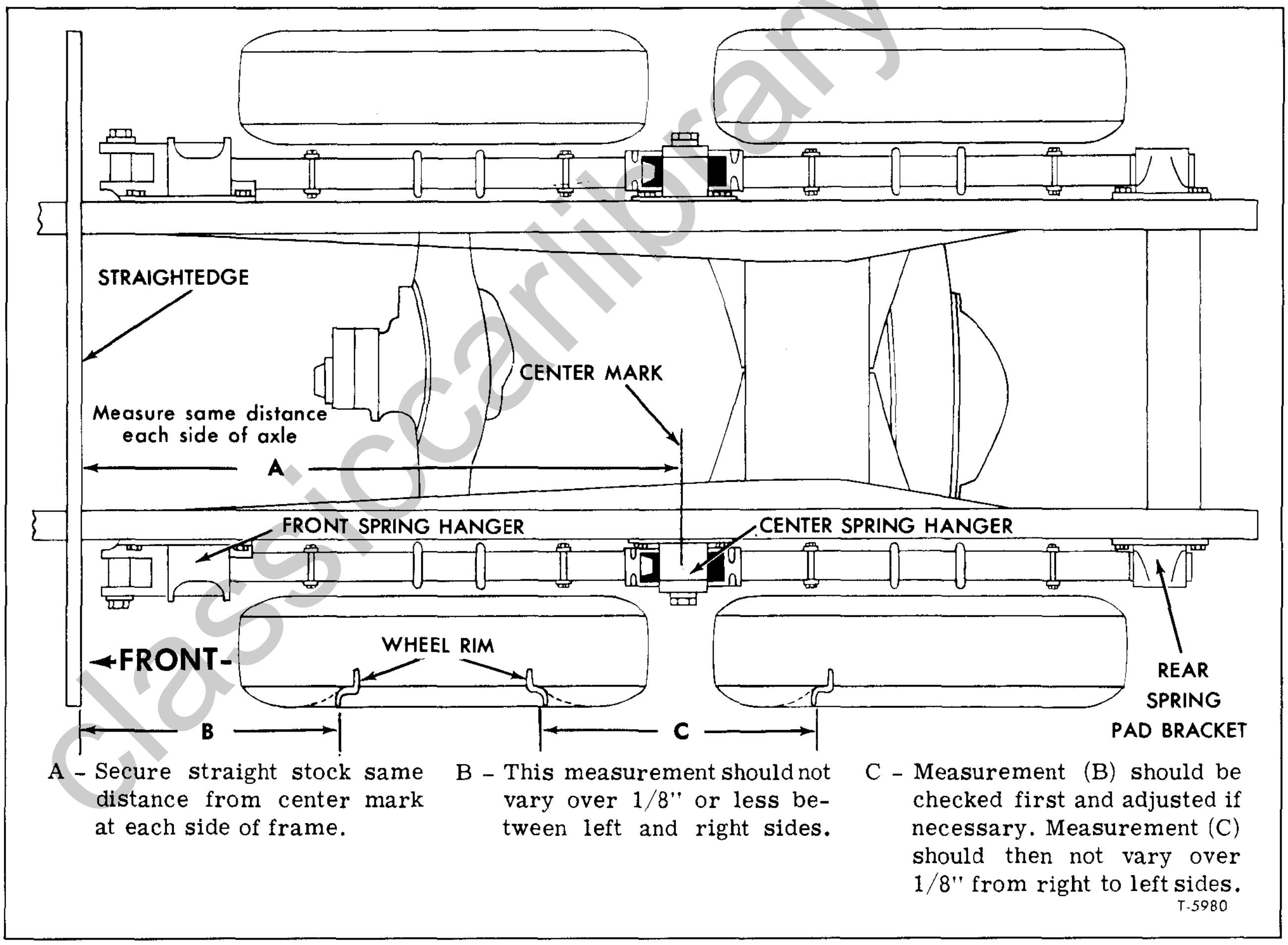


Figure 22—Reyco Tandem Alignment Chart

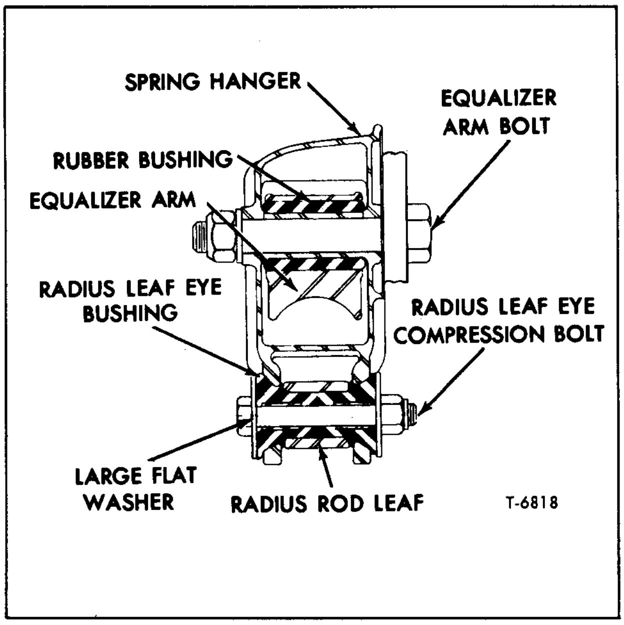


Figure 23—Center Spring Hanger Assembly

adjust, and ensure that both axles are correctly aligned with frame, and that they are parallel with each other: (Refer to fig. 22.)

1. Position truck on level floor and rock back and forth several times with brakes applied lightly, while using vehicle engine power. This will release any set condition of suspension joints.

2. Secure piece of bar stock, angle iron, or other suitable material approximately 96 inches long. Inspect material for straightness. Material should be long enough to extend from outside edge of one outside dual tire, to similar point on opposite outside dual tire as shown in figure 22.

3. Using a tape measure, measure from center point of center spring hanger bracket as shown in figure 21, to any open part of frame in front of wheels, where straight stock can be placed across frame and which is accessible for use of C-clamps.

NOTE: A point forward of front axle is recommended, however, a point rearward of rear axle will suffice if none is available forward of axle.

4. Using a square, scribe a line across top of frame rail, and repeat operation for opposite side of frame after carefully measuring same distance as on side just completed.

5. Position straight stock across frame rails, so that material extends an equal distance beyond frame rail at each side. Line up straight stock on scribed lines and secure with C-clamps at each frame rail.

6. At front side of front tandem wheel, measure from floor to a point approximately at horizontal center of wheel, and mark wheel rim lip at this point. Repeat operation for opposite side of axle, using the same measurement as used previously on other wheel.

7. Measure distance from outside edge at end of secured straight stock, to mark scribed on wheel rim lip.

NOTE: Measure from inside of lip rather than outside edge since outer edge may be irregular and incorrect measurement could result.

8. Repeat the above operation for the opposite side of axle, and compare measurements taken. If measurements are the same, or vary 1/8" or less adjustment is OK. If measurements vary over 1/8" adjustment of axle is necessary and should be adjusted as described in Step 10 following:

9. If the above measurements indicate front axle alignment to frame is satisfactory, rear axle alignment can be checked as follows:

a. Measure distance from rear horizontal center of front outside wheel rim as shown in figure 2 to a similar point at front of rim of rear outside wheel.

b. Repeat operation for opposite side and compare measurements. If 1/8" or less difference is noted, alignment is satisfactory. If a difference of over 1/8" is noted, rear axle must be adjusted as described in Step 10.

NOTE: If straight stock was positioned at rear, of rear axle rather than at front of front axle, the previously described measurement procedure can be reversed to apply to this condition.

10. To adjust axle, loosen nut on radius leaf eye bolt approximately three full turns, and tap end of eye bolt and end of spring, between the front hanger casting. Use soft brass or lead hammer for this purpose to avoid damage to eye bolt threads. This procedure should loosen components sufficiently so adjustment can be readily made.

To adjust axle, one man should place a socket wrench on radius leaf eye bolt, and be prepared to turn bolt in opposite direction of the desired movement of axle. An assistant should then start engine and place the truck in drive, and with brakes applied, carefully release clutch to apply torque to axle. Eye bolt can then be easily moved by this method. Maximum adjustment of 7/16" can be made at each side of axle.

When axle adjustment has been completed and determined to be correct, torque radius leaf eye bolt nut to 200 foot-pounds.

NOTE: If assistant is not available, frame can be jacked up on side to be corrected to relieve weight on springs. Axle can then be adjusted by one man. In most cases, axle alignment can be corrected by adjusting from one side, however if necessary, additional adjustment can be made from other side of axle.

SPRING HANGER REPLACEMENT

FRONT HANGER REMOVAL

1. Raise frame until all weight is off spring and safely block it in position.

2. Remove rebound nut, washer, bolt, and sleeve from front spring hanger.

3. Remove radius leaf rod eye bolt nut, and large flat washer from eye bolt. Using a soft drift tool, drive eye bolt with remaining flat washer from hanger.

4. From inside of rubber bushing, and using a suitable drift tool drive one-half of bushing out of opening. Reverse the position of drift tool and drive other half of bushing from opposite side of hanger.

5. Remove all bolts, nuts, and washers securing spring hanger to frame.

6. Hanger and spacer plate may now be removed by moving it away from spring end and lifting it straight up from frame.

CENTER SPRING HANGER REMOVAL
(Refer to Figure 23)

1. Raise frame until all weight is off spring and safely block it in position.

2. Remove rebound nuts, washers, bolts, and sleeves from ends of equalizer arm.

3. Remove radius leaf rod eye bolt nut and large flat washer from eye bolt. Using a soft drift tool drive eye bolt with remaining flat washer from hanger.

4. From inside of rubber bushing, and using a suitable drift tool, drive one-half of bushing out of opening. Reverse the position of drift tool and drive other half of bushing from opposite side of hanger.

5. Remove all bolts, nuts, and washers which secure center hanger to frame.

6. Remove hanger and spacer plate by lifting straight up from frame and springs.

REAR SPRING BRACKET REMOVAL

1. Remove bolts, nuts, and washers, which secure rear bracket to frame. Remove bracket and spacer plate.

REAR SPRING BRACKET
PAD REPLACEMENT

1. Remove two cap screws from each end of bracket, remove retaining straps, and rubber pad. To install new rubber pad, reverse the above procedure.

INSTALLATION OF ALL SPRING HANGERS

Spring hanger brackets may be installed by reversing the above removal procedure. Install units with spacer plates between frame and hanger. Alignment adjustment of axles should be checked and adjusted if necessary before final torquing of radius leaf eye bolt nut.

For Specifications concerning Leaf Type Suspensions, refer to the end of Section 4B.

AIR SUSPENSION

SYSTEM DESCRIPTION

The air suspension system consists mainly of air springs (bellows), height control valve, control arms, and shock absorbers. The air suspension system is schematically illustrated in figure 1. The system operates automatically as load varies, and retains frame at a pre-determined ride height.

AIR BELLOWS

An air bellows is mounted between each control arm and frame support bracket. The bellows assembly consists of the upper and lower bead plates, girdle hoop, air spring rubber section, and built in height bumper (fig. 2).

HEIGHT CONTROL VALVE

Height control valve operates when load above valve increases, or decreases, automatically increasing or decreasing pressure in the bellows. The height control valve is frame-mounted and attached to the forward rear axle by a non-adjustable link.

AXLE CONTROL ARMS

Control arms locate rear axle in position and transmit driving and braking forces to frame and provide roll stability.

SHOCK ABSORBERS

Two double-acting shock absorbers are used at each rear axle to dampen suspension oscillations. Shock absorbers are mounted at each end with replaceable two-piece rubber bushings.

SYSTEM OPERATION

Compressed air, metered into the air suspension system by height control valve, is taken from the air reservoir. Pressure regulating valve allows removal of air from reservoir only when pressure exceeds 65 psi. This is to assure pressure for brake system in event of leakage in suspension system. Height control valve is actuated by the relative movement between frame and suspension.

LOADING

As frame settles under an increased load, height control arm linked to forward rear axle is moved upward. As the arm actuates the valve, a sufficient volume of air is admitted to all four bellows to maintain frame at normal ride height.

UNLOADING

The distance between axle and frame will increase as load is removed. Height control valve, in this case, will exhaust air from bellows in proportion to decrease in load. Refer to "Height Control Valve" later in this section for detailed description of operation.

The height control valve is designed to operate only when load is increased or decreased. The valve does not respond to rapid relative motion

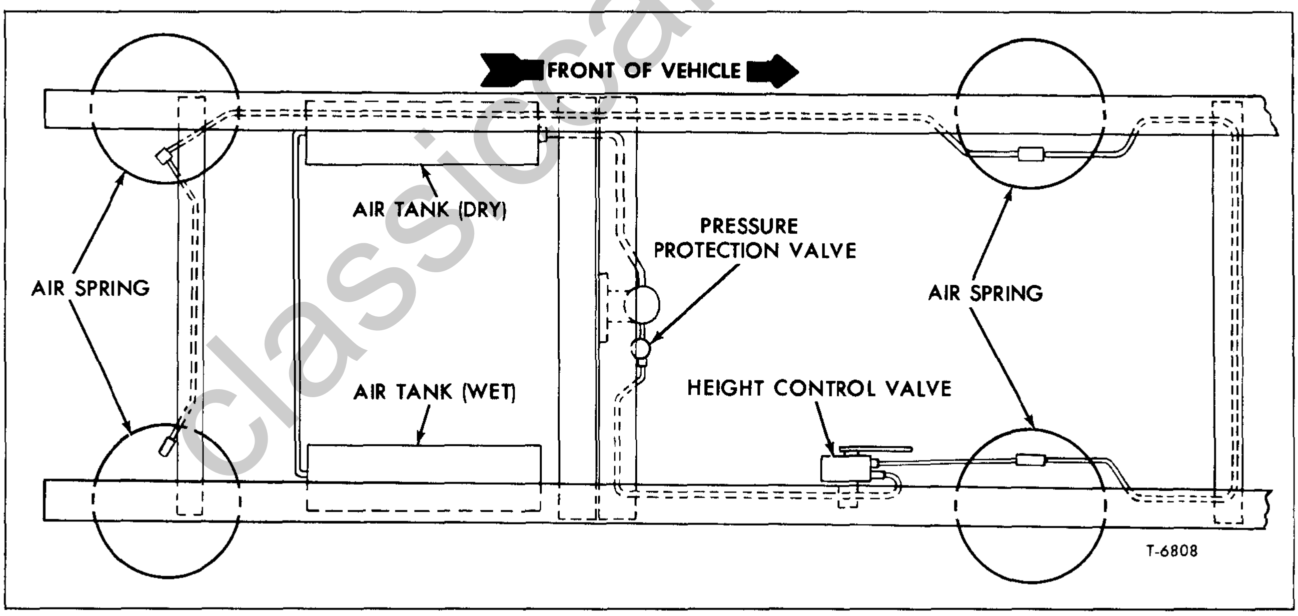


Figure 1—Suspension Air System

between axle and frame such as that caused by road irregularities.

The bellows serve as a flexible connection between the frame and rear axles. Flexing of the air bellows results in an alternate increase and decrease of air volume. This action absorbs road shocks in the same manner as an inflated rubber tire cushions shock caused by road roughness.

Shock absorbers are double-acting, piston-type. These shock absorbers control rear axle rebound and further cushion ride. Axle control arms locate rear axles against lateral, longitudinal, and torsional movement.

SYSTEM MAINTENANCE

The air suspension system requires little maintenance other than routine test and inspection. Inspection and test procedures should be performed at established chassis inspection periods. Components of suspension are shown in figure 2.

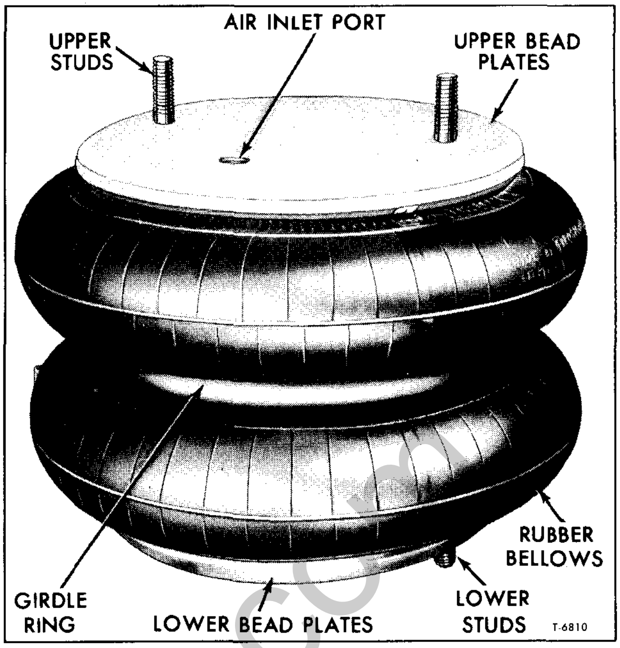


Figure 2—Air Bellows Components

CAUTIONS

1. Lifting Vehicle

Front of vehicle can be raised in normal manner, however, when jacking up rear axles position jack or hoist so as not to damage bellows.

2. Working Clearance

Before working on air suspension, support frame as follows: At rear axles, place a block between axle housings and frame to prevent sudden dropping motion of frame, which could injure working personnel.

3. Towing

When vehicle is to be towed with rear axles hanging free, chain axles to frame to pervent axles from hanging by bellows only.

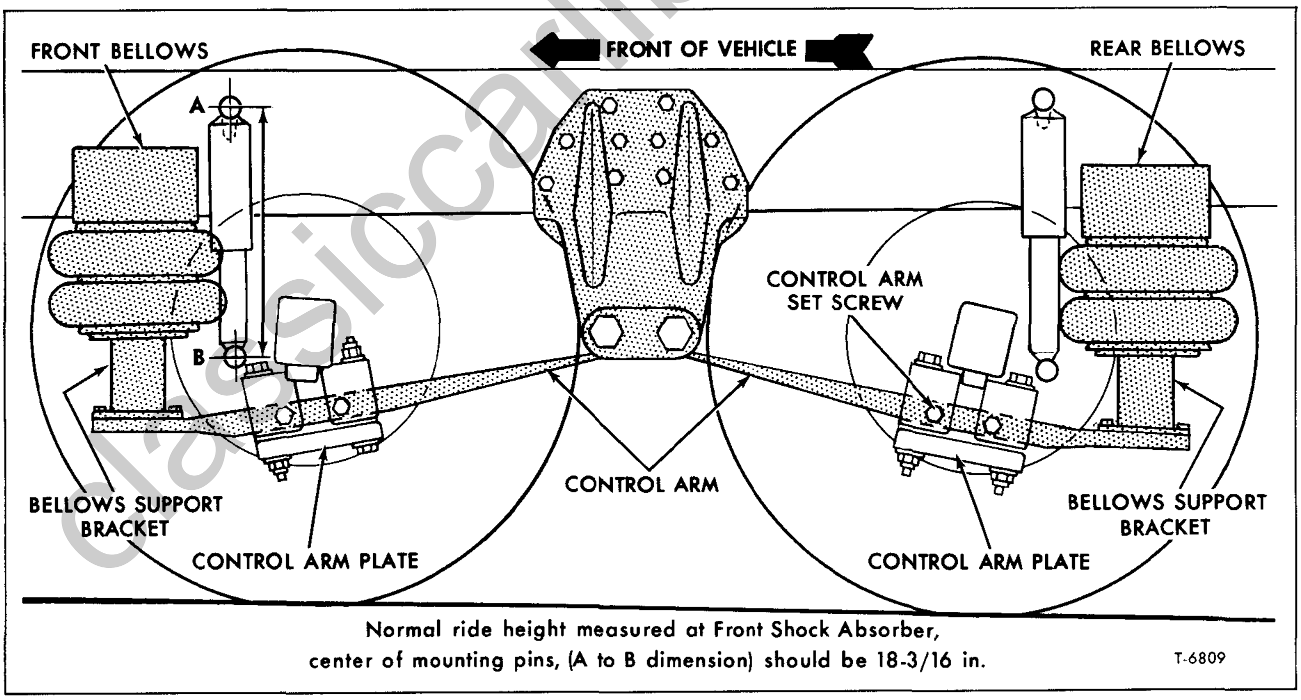


Figure 3—Air Suspension Components

4. No Lubricant

Use of lubricant of any kind on axle control arm bushings is unnecessary. Keep surface of bellows free from accumulated oil or grease.

AIR TANKS

Air tanks must be drained at regular intervals to keep air system as free from moisture as possible.

AIR LEAKAGE TEST

Build up pressure in the main air system to normal operating pressure (approximately 105-120 psi). Coat all air suspension air line connections, bellows, and height control valve with a solution of soap and water. Air leakage will produce soap bubbles. No leakage is permissible. Leakage at an air line connection can generally be stopped by tightening connection.

MOUNTING AND BELLOWS INSPECTION

Check attaching bolts or nuts for proper torque as listed in "Specifications" at end of this section. Inspect all bellows for cracks, abrasions, or other damage which might develop into a rupture.

HEIGHT CONTROL VALVE

Normal operating air pressure is approximately 105-120 psi. At this pressure, height control valve will automatically meter air into or out of bellows as load changes.

IMPORTANT: Vehicle should be level when making any height control checks or adjustments.

Normal Ride Height

Ride height measurements are taken between the shock absorber mountings at forward axle of the tandem series. Measurement should be 18-3/16 inches from center of bottom shock mounting pin to center of top shock mounting pin (fig. 3).

Overtravel Lever Adjustment

Change position of valve lever on overtravel assembly if necessary, to obtain the normal ride height dimension. Position of lever may be changed by loosening adjusting nut. Intake and exhaust valves of height control valve can then be operated independently of linkage.

NOTE: End of height control valve lever will move ½-inch up or down from neutral position (free travel) without causing any valve acting, due to a time delay of approximately four seconds. If amount of adjustment required falls within these limits, adjust lever the required amount as directed later. However, frame will not raise or lower until load is increased or decreased to actuate height control valve.

If the height control valve does not function properly with the lever correctly adjusted, check for air line restriction. If valve still does not hold frame at normal ride height with lever properly adjusted, and with no restriction in air supply, valve should be removed and overhauled or replaced with a new or rebuilt unit. Refer to "Height Control Valve" later in this section.

REAR AXLE CONTROL ARMS

Four control arms (fig. 3) equipped with replaceable rubber bushings, attach rear axle to frame brackets. Control arms are secured to axles by clamp bolts and anchor plates. A Delrin liner is used on top and bottom of control arms at axle. Control arms are secured to frame brackets by bolts and nuts. Cross section of control arm-to-frame bracket mountings is shown in figure 4.

CONTROL ARM REMOVAL

1. Raise frame to remove load from rear suspension and block frame securely.
2. Remove two bolts which attach bellows support bracket to control arm.
3. Remove bolt and nut attaching control arm to frame bracket. Loosen adjacent fastener to lessen clamping effect of casting.
4. Remove four nuts securing control arm anchor plate to control arm at axle bracket using caution to prevent control arm from surface damage by pry bars, hammers, etc. Nicks and gouges cause stress risers and are detrimental to long life. Loosen inboard setscrews only which prevents side movement of the control arm in axle bracket.
5. Remove control arm, noting location of Delrin liners at top and bottom of control arm. Liner must cover entire clamping surface and extend slightly beyond each edge of bracket.

BUSHING REPLACEMENT (Fig. 4)

Press bushing from end of control arm. Clean inside surface of control arm eye, making sure bushing bore is smooth. Press bushing into control arm until bushing outer sleeve is flush with each side of control arm eye. Use no lubricant on bushings. Press in load should be approx. 7000-9000 lbs.

CONTROL ARM INSTALLATION

IMPORTANT: Before final torquing of control arm to frame bracket bolts and nuts, the rear suspension should be at normal ride height. If connections are tightened without first obtaining this adjustment, a torsional preload will be imposed on rubber bushings when the frame assumes normal height relative to axle.

1. Position Delrin liners, one on top and one at bottom of control arm. These can be held in

place with masking tape while installing control arm. Tape must not be between bracket and liner.

2. Note that dowel pin hole is clean in control arm and axle bracket. Insert dowel pin and raise control arm into position at frame bracket and axle bracket. Install control arm anchor plate and loosely install attaching bolts and nuts.

3. Align control arm to frame bracket and loosely install attaching bolt and nut.

4. Install two bolts and nuts attaching bellows pedestal brackets control arm.

5. After establishing vehicle at normal ride height by jacking up frame, torque control arm anchor plate and control arm to frame bracket bolts to 490 to 520 foot-pounds torque. Adjust control arm movement setscrews by turning bolt in until no clearance is detected and tighten jam nut.

6. Remove blocking and return vehicle to normal ride height.

AIR BELLOWS

Bellows are made of rubber with fabric reinforcement. Both ends of bellows are sealed with bead plates, which attach bellows assembly to vehicle. A girdle ring is used between convolutions to maintain bellows configuration.

Four bellows are used to support rear of vehicle. Each bellows is installed between axle control arm and frame brackets. No maintenance of bellows is required other than regular inspections to detect chafed or damaged areas which could lead to bellows failure. Bellows are to be serviced as an assembly.

BELLOWS REMOVAL

1. Jack up vehicle and secure frame with blocking.

2. If system is pressurized, disconnect height control valve link and disconnect air line at bellows to be changed, this will relieve pressure within the air suspension system.

3. Remove nuts from two bellows bead plate studs at frame.

4. Remove nuts from two bellows bead plate studs at bellows pedestal bracket.

5. Compress bellows assembly to free studs and remove bellows assembly.

BELLOWS INSPECTION

Clean bellows and bellows bead plates thoroughly. Examine bellows for evidence of cracks, punctures, deterioration, or chafing. Inspect bellows bead plates for dents or other damage that could cause air leaks. Check mounting studs on bead plates for damaged or stripped threads. Threads in fitting holes should be in good condition.

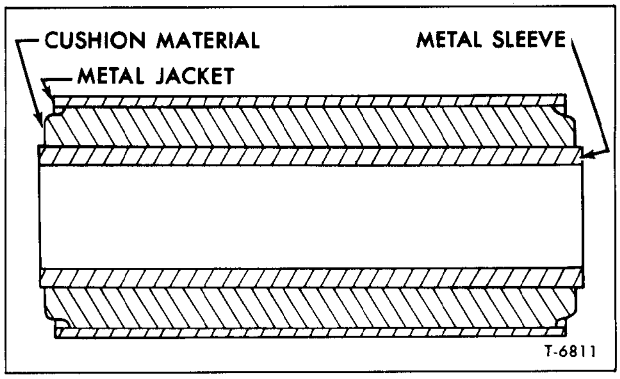


Figure 4—Control Arm Bushing Cross Section

Bellows can be lightly inflated and submerged in water to detect any leakage. If any leakage is detected between bellows and bead plates, under girdle ring, or in the rubber section itself, replace the bellows assembly.

BELLOWS INSTALLATION

1. Compress bellows assembly and position in place (with air inlet fitting toward center of vehicle) bellows bead plate studs through holes in lower bellows support, start nuts to retain bellows to lower support bracket.

2. Insert top bellows bead plate studs through holes in upper bellows support bracket. Start nuts and torque nuts of upper and lower bellows studs to 8 to 12 foot-pounds torque.

3. Connect air line to bellows top bead plate fitting and connect height control valve link (if disconnected).

4. Remove blocking from frame and run engine or hook shop air line to provide air for suspension.

5. Check function of bellows and check air line

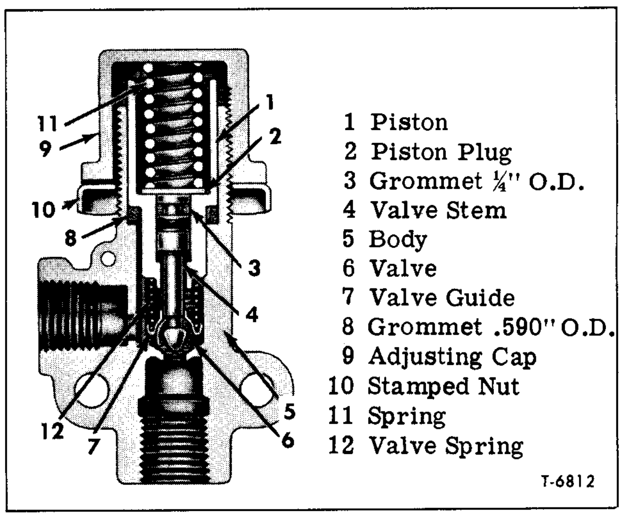


Figure 5—Pressure Regulating Valve

connections with a soap and water solution for leaks. No leakage is permissible.

PRESSURE REGULATING VALVE

Pressure regulating valve (fig. 5) is mounted on frame near air tank. This valve serves two purposes. One purpose is to prevent air pressure from entering air suspension system until pressure in the air system reaches 65 psi. This provides a rapid build-up of air pressure for operation of brake system. When brake system air pressure exceeds 65 psi, the pressure regulating valve opens and allows pressure to build up in air suspension system. The second purpose of the valve is to prevent loss of brake system air pressure below 65 psi due to leakage in air suspension system.

SERVICEABILITY TESTS

Operating Test

1. Exhaust pressure from system by opening drain cock at air tank. Close drain cock when air is expelled.
2. Connect a test air pressure gauge in brake system, preferably in the line leading from air tank to pressure regulating valve.
3. Disconnect the air line that leads to height control valve.
4. Build up pressure in system and note pressure on test gauge at the same time valve opens and discharge air through open line.
5. Adjust valve if pressure varies 5 psi from the original setting (65 psi).

Leakage Test

Refer to figure 5 for a detailed cross section of valve.

With air line still disconnected that leads to height control valve, build up air pressure to a point just below valve setting (65 psi). Coat opening of disconnected fitting on valve with soap and water solution to check for leakage. Also apply soap solution to vent opening in valve cover.

No leakage is permissable at vent opening in valve cover. Leakage at this point indicates worn or dirty internal parts and should be disassembled and overhauled as described later in this section.

ADJUSTING PRESSURE SETTING

NOTE: Key numbers in following text refer to figure 5. The adjusting cap (9) controls the pressure at which the valve is unseated. Setting may be increased or decreased by turning cap.

1. Back off lock nut (10).
2. Turn cap (9) clockwise to increase pressure, or counterclockwise to decrease pressure.
3. Tighten lock nut (10) when correct adjustment is obtained.

DISASSEMBLY

NOTE: Key numbers in following text refer to figure 5.

Remove cap (9), spring (11), piston (1), then remove O-ring (8) from valve body (5). Holding piston assembly (1), push valve stem (4) upward to remove piston plug (2) from piston (1). Compress valve spring (12) to remove valve guide (7) by prying off valve (6) from valve stem (4).

INSPECTION

NOTE: Key numbers in following text refer to figure 5.

Clean all parts thoroughly, using a suitable cleaning solvent. Examine piston (1) for cracks or wear. Inspect valve seat in valve body (5). If seat is pitted, scratched, or chipped, replace the body. If O-rings are worn or hardened from age, replace them.

ASSEMBLY

NOTE: Key numbers in following text refer to figure 5.

Insert O-ring (8) into valve body (5). Insert valve stem (4) into piston (1). Back up valve stem with a small tool so sufficient force can be exerted to compress valve spring (12) and position valve guide (7). Push end valve (6) onto knob of valve stem which will serve to retain these parts as an assembly. Lubricate inside of valve body with a small amount of barium base lubricant and install piston assembly into bore of valve body. Install piston plug (2) followed by spring (11). Thread adjusting cap down until spring can be felt compressing. Set valve adjustment as directed previously under "Adjusting Pressure Setting."

HEIGHT CONTROL VALVES

DESCRIPTION

Height control valve automatically maintains a constant vehicle height by controlling the flow of compressed air into or out of suspension system air bellows. One height control valve is used at forward rear axle of the tandem series. A delay piston contained in each valve provides a momentary delay in intake and exhaust valve action; therefore, air in bellows is supplied or exhausted only during load changes and not during intermittent road bumps.

The height control valve contains an intake valve, air bellows outlet, exhaust valve, delay piston, and overtravel control body. The overtravel control body contains a spring-loaded nylon piston which protects valve parts if overtravel lever is moved beyond normal operating range. A check valve is also provided in the air inlet tube fitting.

HEIGHT CONTROL VALVE OPERATION

Figure 6 shows cross-section of a valve assembly in the three phases of operation. Valve operation is illustrated as vehicle is unloaded, at normal ride height, and as vehicle is loaded. The valve adjusts for the following conditions:

Loading

When vehicle is being loaded, frame tends to settle. Since valve is linked to axle, and valve is bolted to frame, valve moves downward with frame as vehicle is loaded. As overtravel lever and control shaft turns, a force is applied to the delay piston which moves slowly and allows the intake valve lever to move against the intake valve core. As pin is pushed in, air pressure flows through height control valve into bellows. Increased air pressure expands and raises frame.

Inlet valve is "protected" by check valve (refer to fig. 6) in inlet adapter. Light spring in core freely admits tank air, but return flow of air is blocked.

Neutral Position

As increased air pressure expands bellows and lifts frame, the height control valve moves upward with frame. As frame is returning to normal ride height, overtravel arm and shaft return to a neutral position. Inlet valve lever also moves away from inlet valve core and inlet valve closes. This stops the flow of air into bellows. The exhaust valve remains closed. Since the exhaust valve is closed, and the check valve in the inlet adapter prevents compressed air from returning to tank, air is trapped in bellows and in valve. No further valve action or air pressure change takes place until load is increased or decreased, moving over-travel lever out of neutral position for two seconds or more to actuate intake valve or exhaust valve.

Unloading

When part of load is removed, air pressure in bellows lifts frame. Overtravel lever, linked to axle in rear, is pulled downward from neutral position. This applies a force on the delay piston, which moves it slowly. The exhaust valve lever moves with the delay piston. The outer end of exhaust valve lever fits around stem of exhaust valve core. As soon as lever moves beyond free-travel range, lever pulls on stem and opens exhaust valve. Inlet valve remains closed. Compressed air from bellows then flows through the open exhaust valve and out exhaust fitting to atmosphere. As the compressed air is exhausted from bellows, the frame lowers until overtravel lever and shaft are again in normal (neutral) position.

Overtravel Lever Free-Travel

With vehicle in motion and frame at normal ride height, control valve overtravel lever and shaft are in neutral position as shown in figure 6. Small irregularities in road cause slight up and down movement of overtravel lever. Clearances are provided between operating levers and cores of inlet and exhaust valves to permit 3/8-inch up or down movement of overtravel lever from neutral

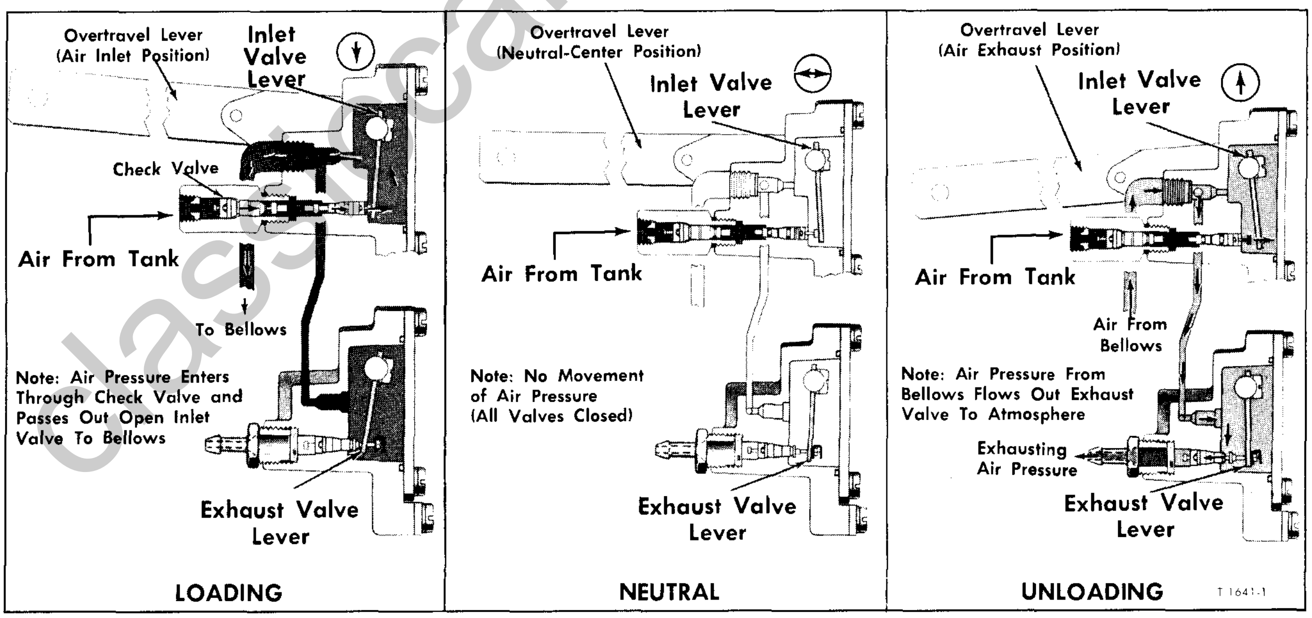
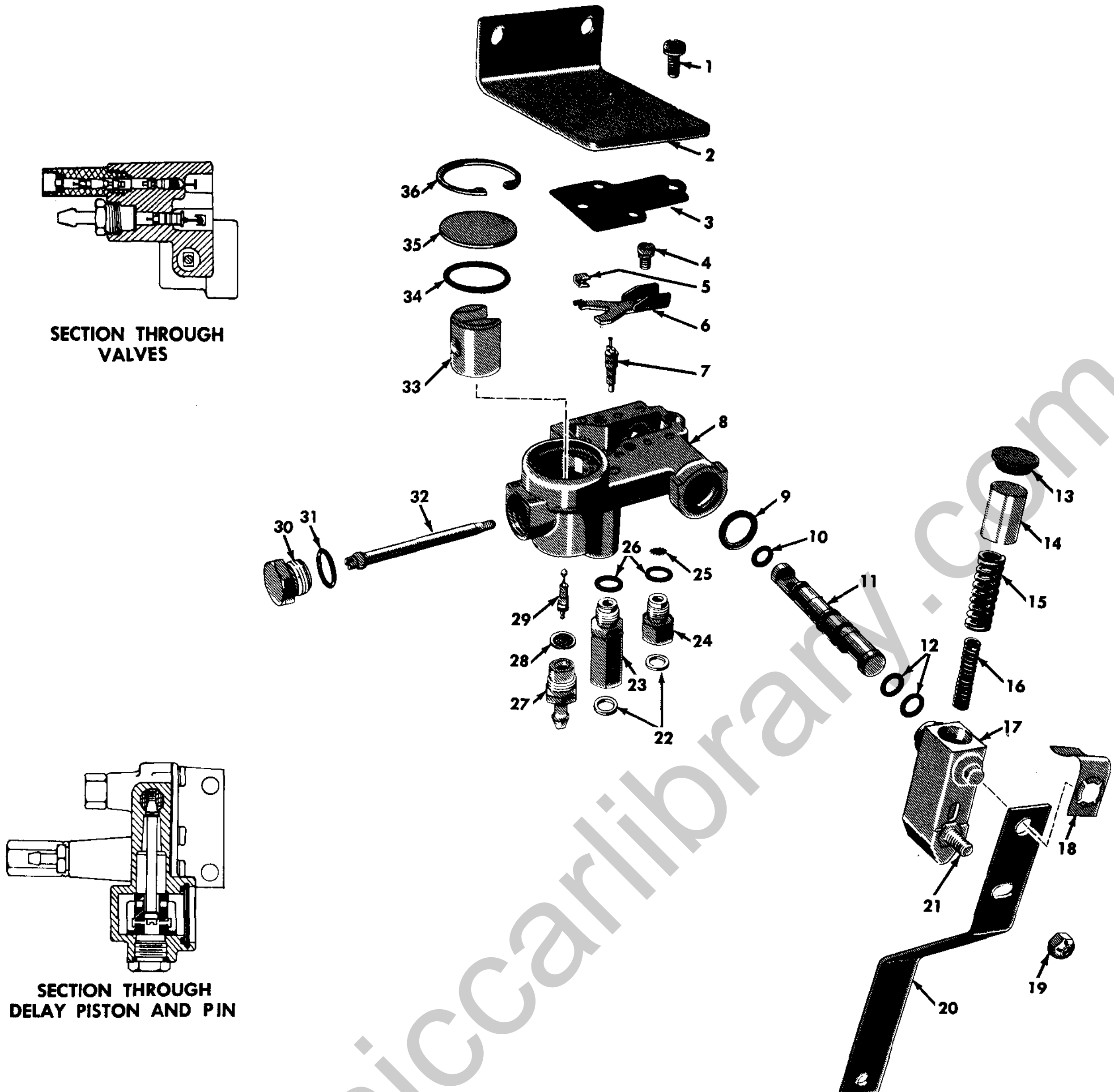


Figure 6—Operation of Height Control Valve



1 Cover Screw and Lock Washer
2 Cover and Bracket
3 Cover Gasket
4 Valve Lever Screw
5 Valve Stem Lock Clip
6 Intake and Exhaust Valve Lever
7 Intake Valve Core
8 Valve Body
9 Overtravel Control Body Seal
10 Shaft O-ring (Medium)
11 Overtravel Control Shaft
12 Shaft O-ring (Large)
13 Overtravel Body Plug
14 Overtravel Piston
15 Overtravel Spring (Large)
16 Overtravel Spring (Small)
17 Overtravel Control Body
18 Plug Retainer
19 Lever Stud Nut
20 Overtravel Lever
21 Overtravel Lever Stud
22 Airline Fitting Gasket
23 Inlet Adapter and Check Valve Assembly
24 Outlet Adapter
25 Outlet Adapter Screen
26 Adapter O-ring
27 Exhaust Fitting
28 Exhaust Screen
29 Exhaust Valve Core
30 Delay Plug
31 Plug O-ring
32 Piston Pin
33 Delay Piston
34 Delay Cover O-ring
35 Delay Cover
36 Delay Cover Retainer

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Figure 7—Height Control Valve Components

position without causing valve action. This compensates for small road bumps. The bumps are absorbed by tires and bellows without causing movement of compressed air either into or out of suspension system.

Hydraulic Delaying Action

Operation of delay piston (fig. 7) in height control valve prevents change of bellows air pressure as a result of momentary road shocks, conserves air supply, and adds life to valve. The nylon piston moves inside cylinder containing a silicone type fluid. A flapper valve on either end of piston allows displacement of fluid or acts as a check valve, depending on direction piston moves. Delay piston is moved by piston pin (fig. 7), that is threaded into overtravel shaft. A 2 to 9 second delay results from the closing of one valve to the opening of other valve.

Overtravel piston (refer to fig. 7) is held against flat side of overtravel shaft by two springs inside piston. Piston keeps overtravel shaft in proper position relative to overtravel lever. Piston also allows overtravel lever to rotate through a complete circle, if necessary, without damaging parts inside valve.

HEIGHT CONTROL VALVE REMOVAL

Before disconnecting any height control valve air lines, securely support frame by placing blocks between frame and axles. Exhaust air from air supply system by opening drain cock on air tank. After the above precautions have been taken, remove height control valve as follows:

1. Disconnect height control valve overtravel lever from valve link. Pull lever downward and hold several seconds to overcome time delay feature; this will release compressed air from bellows.
2. Disconnect air supply line and bellows air line from height control valve. Tape ends of lines to prevent foreign material entering.
3. Remove two bolts, nuts, and flat washers attaching height control valve to mounting bracket and remove valve assembly.

HEIGHT CONTROL VALVE INSTALLATION

Before installing height control valve assembly, see that air line fittings are clean and undamaged. Replace line connector rubber seals if deteriorated or damaged.

NOTE: DO NOT USE SEALING COMPOUND ON THREADS. Sealer is unnecessary, and if used, may cause valves to stick. Absolute cleanliness is essential when installing height control valves. Dirt and sealing compound must be kept out of

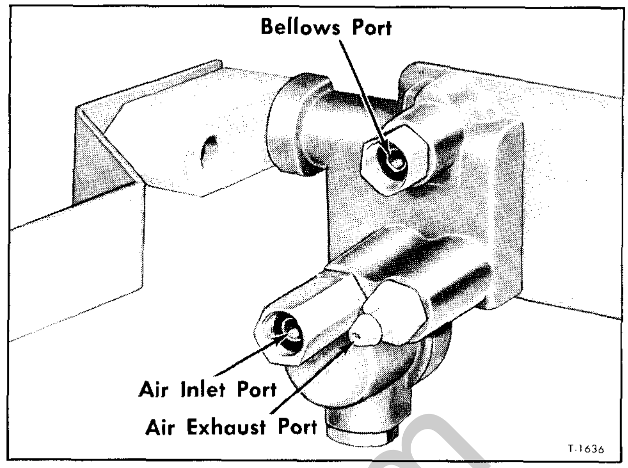


Figure 8—Identification of Valve Air Ports

valves. Even minute particles of foreign matter may become lodged in valve cores or flapper valves and may seriously affect operation of suspension system.

1. Position height control valve at mounting bracket. Attach with two bolts, nuts, and flat washers and tighten to torque listed in "Specifications" at end of this section.
2. Connect air supply line to intake check valve adapter. Connect bellows air line to outlet adapter. Tighten air line connector nuts firmly.
3. Connect height control valve overtravel lever to valve link. Build up air pressure in system and test for leaks. Check ride height dimension and adjust if necessary.

HEIGHT CONTROL VALVE AIR LEAKAGE CHECK

NOTE: Air leakage check can be pefformed for bellows mountings and air line connections only, when valve is installed on vehicle. The following instructions explain procedure for performing air leakage check when valve assembly is removed from vehicle.

1. Clean exterior of valve assembly.
2. Connect air pressure line to air inlet port (fig. 8), then open the air pressure (80-110 psi).
3. Submerge valve assembly in a container of water, then watch for air bubbles when the overtravel lever is in center (neutral) position. No air should escape from any point of valve assembly.
4. If bubbles appear from the bellows port, this is an indication the air inlet valve assembly is defective and must be replaced.
5. Remove air pressure line from air inlet fitting and connect it to the bellows port (fig. 8). If bubbles appear at the air inlet check valve port, this is an indication that check valve unit is defective and must be replaced.

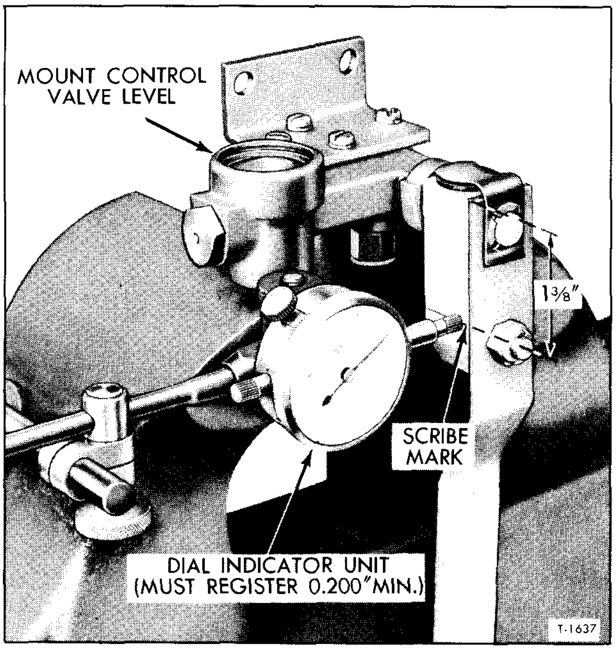


Figure 9—Dial Indicator Properly Installed

6. If bubbles appear at the exhaust port (fig. 8), it is an indication the exhaust valve assembly is defective and must be replaced.

7. If bubbles appear around edge of valve cover plate, the cover plate gasket must be replaced.

8. If no leaks are detected, remove valve assembly from water, then with air pressure still connected to bellows port, actuate overtravel lever to expel any water which may have entered exhaust valve chamber. Remove air line and connect it to air inlet port and repeat operation to remove water from air inlet valve chamber.

HEIGHT CONTROL VALVE ADJUSTMENTS

To properly adjust the height control valve, it is ESSENTIAL that the following procedures be followed and in the sequence mentioned:

Three main adjustments are required.

NOTE: The height control valve assembly must be removed from vehicle to perform the following adjustments:

1. Overtravel lever center position adjustment
2. Air intake and exhaust valve lever gap adjustments.
3. Time delay check.

IMPORTANT: The silicone fluid should be drained from valve assembly before performing the first two adjustments mentioned previously.

NOTE: The following tools should be used when performing valve adjustments:

REQUIRED TOOLS

Tool	Tool Number
Valve Core Replacer	J-6888
Overtravel Lever Piston Compressor	J-8424
Allen Wrenches (Sizes 3/32-inch and 1/8-inch)	Procure locally
Stop Watch	Procure locally
Dial Indicator Set (Having minimum range of 0.020 inch)	Procure locally
Air Line Fitting Assembly Consists of:	
(1) 2-Inch length of ¼ H-9 hose	Procure locally
(1) Weatherhead pipe fitting	00904-104
(1) Weatherhead inverted fitting	00904-B04
Vacuum Line Fitting	Sun Tester #115-3
Depth Gauge and Straightedge	Procure locally
Conventional Type Eye Dropper	Procure locally

OVERTRAVEL LEVER CENTER POSITION ADJUSTMENT

1. Clean exterior of control valve assembly.
2. Remove delay piston snap ring retainer, cover, and O-ring from control valve assembly, then drain off the silicone fluid.
3. Remove exhaust fitting and exhaust screen from valve.
4. Referring to figure 9, scribe a line 1-3/8-inch from plug end of overtravel lever control body.
5. Place valve assembly in vise as shown in figure 9.
6. If vacuum source is available, attach supply hose to valve exhaust port (fig. 8) using Sun Tester fitting #115-3 or equivalent. Do not apply vacuum at this time.
7. Attach air pressure supply hose to air inlet port (fig. 8). Do not apply pressure at this time.
8. Locate dial indicator in position as shown in figure 9. Move overtravel lever to full air exhaust position - TOP OF DELAY PISTON FLUSH WITH TOP OF BORE - without overtraveling (position "C," fig. 10). Relocate indicator push rod to just contact 1-3/8-inch mark on control body and reset indicator dial to zero (0) at this point (position "C," fig. 10).
9. Move overtravel lever to full air intake position without overtraveling (position "A," fig. 10) (delay piston at bottom of bore). Take indicator reading which may vary from 0.160" to 0.190".
10. Repeat steps 8 and 9 above to recheck this reading.
11. Divide the total travel dimension by two (example: 0.170" - 2 - 0.085"), then move overtravel lever back this amount (0.085") to the center (position "B," fig. 10).

IMPORTANT: Without disturbing lever center position, reset indicator dial to zero (0), which actually is 0.100" on indicator of type registering

0.100" for each revolution of indicator needle, then proceed with valve lever gap adjustments following:

AIR INTAKE AND EXHAUST VALVE LEVER ADJUSTMENTS

IMPORTANT: Before making these adjustments the overtravel lever must be centered as explained previously.

Two methods of adjustment are available:

1. Using Both Air Pressure and Vacuum
NOTE: If vacuum source is available, this method will take less time to perform adjustment. Vacuum source is used to make the exhaust valve lever gap check only.

2. Using Air Pressure Only
NOTE: When this method is used, it will take longer to perform adjustments as the valve cover must be in place each time air pressure is applied and then removed to permit adjustment of exhaust valve lever.

Instructions covering lever adjustments are identical for front and rear valves. Rear valve lever and front valve lever must be bent to proper setting. In these valves both exhaust and intake levers are part of one unit which contains "score" marks to permit easy bending. Mechanics may accomplish this operation with lever in the valve body, or lever may be removed and bent on the bench.

METHOD USING AIR PRESSURE AND VACUUM

1. If air supply and vacuum lines were not connected to valve assembly as directed previously when centering valve overtravel lever, connect lines.

2. Apply air pressure and regulate it to 80 to 110 psi. Apply vacuum and regulate it at approximately 15 inches.

3. Move overtravel lever fore and aft several times and then back to true center position.

4. Starting at true center position, slowly move lever to where air intake valve just begins to open. Listen for escaping air. Note reading on dial at this point. Reading should be 0.025" to 0.027" from lever center position. If necessary, bend intake valve lever to correct setting (fig. 11).

5. Return overtravel lever to center position. Slowly move lever to exhaust side and at same time note the vacuum gauge reading. When vacuum just begins to fall off, the exhaust valve has opened. Valve should open when overtravel lever is moved 0.035" to 0.037" from center position. If necessary, bend exhaust valve lever to correct setting (fig. 11).

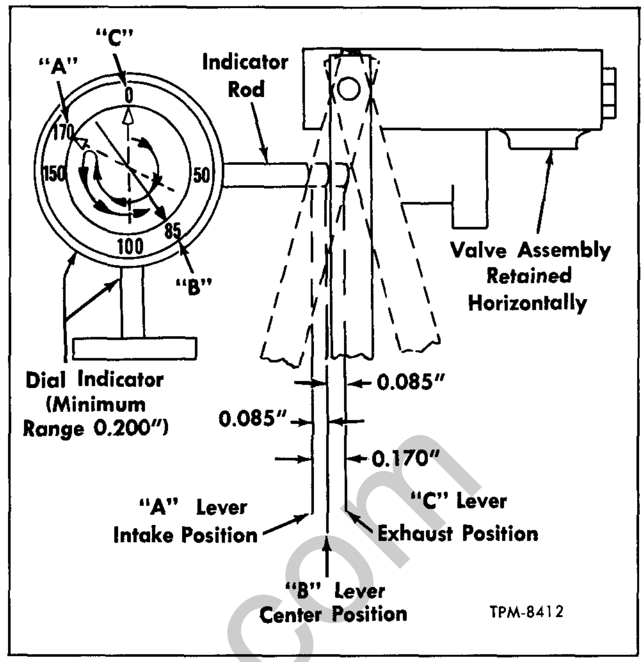


Figure 10—Locating Valve Overtravel Lever Center Position

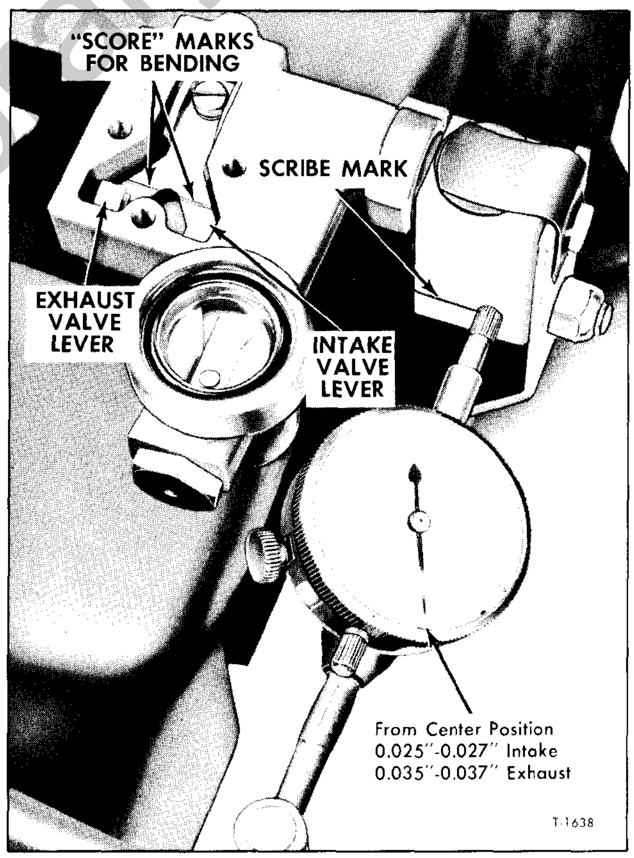


Figure 11—Adjusting Air Valve Lever Gap

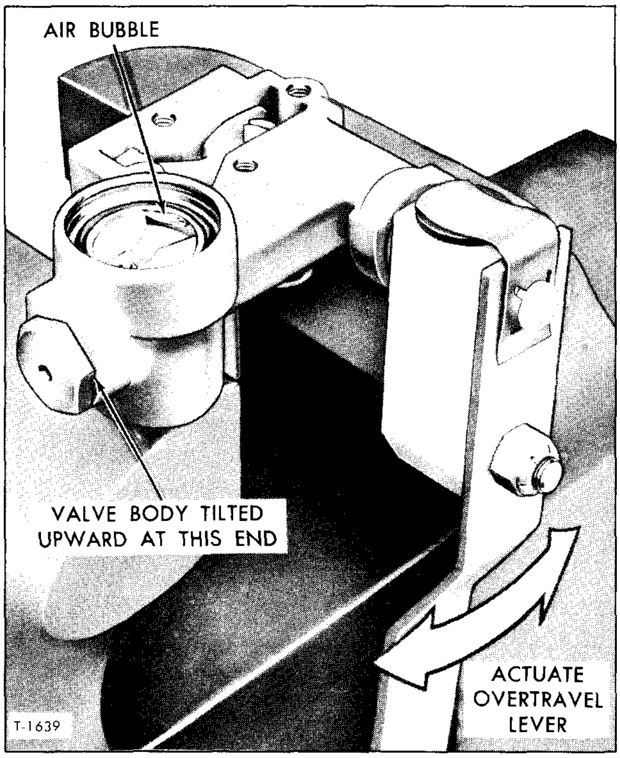


Figure 12—Venting Air from Silicone Fluid

6. Recheck intake and exhaust valve lever gaps, then proceed with "Time Delay Check" explained later.

METHOD USING AIR PRESSURE ONLY

NOTE: This method may be performed when a vacuum source is not available.

1. Connect air supply hose (80 to 110 psi) to air inlet port (fig. 8).

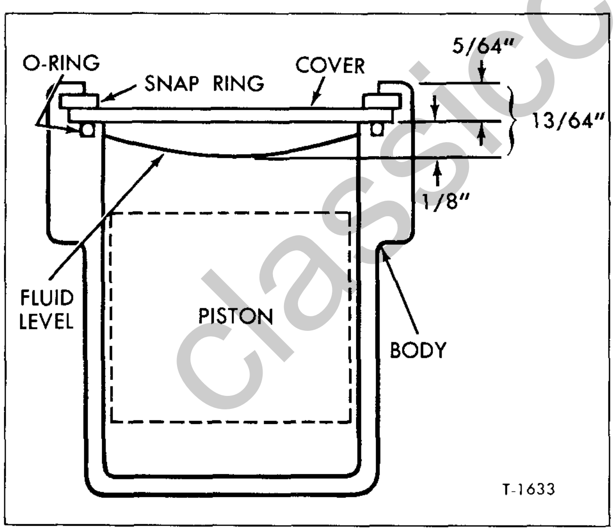


Figure 13—Silicone Fluid Level

2. To adjust air intake valve lever gap:

a. Move the overtravel lever slowly from true center position to point where intake valve just begins to open. Listen for escaping air. Note reading on dial at this point which should register 0.025" to 0.027".

b. If necessary, bend intake valve lever to correct setting (fig. 11).

3. To adjust air exhaust valve lever gap:

a. Install valve cover on the valve using a new gasket and four attaching screws.

b. Being careful not to disturb indicator setting, disconnect air supply from the air inlet port and connect it to the bellows port (fig. 8).

c. Move overtravel lever slowly to open exhaust port while observing the indicator dial. Air should start to escape from exhaust port when indicator registers 0.035" to 0.037". If adjustment is necessary, shut off air pressure supply and remove valve cover. Bend exhaust valve lever to correct setting, then install cover and recheck valve opening dimension.

d. Recheck valve lever gaps, then proceed with "Time Delay Check" following:

TIME DELAY CHECK

PRELIMINARY PROCEDURES

After the valve lever gaps have been properly adjusted, the time delay check must be performed. A 2 to 9 second delay from the closing of one valve to the opening of the other is recommended.

1. Place new O-ring over delay plug, then install plug into valve body. Tighten plug to torque listed in "Specifications."

2. Pour 6.0 cc ± 0.25 cc of silicone fluid (1000 Centistokes viscosity at 25°C) into delay piston bore. With valve body tilted slightly as shown in figure 12 carefully operate overtravel lever fore and aft to vent air from fluid. When all air has been expelled from piston pin cavity, check fluid level using depth gauge as shown in figure 13.

IMPORTANT: With valve assembly level, take measurement from center of bore only. Add or remove fluid to bring fluid 13/64-inch from top of valve body. An eyedropper will serve for this purpose.

3. Place new delay piston cover O-ring in groove of valve body. Install cover with snap ring retainer.

4. Place valve assembly vertically in holding vise (fig. 14).

5. Move overtravel lever up and down for approximately one minute.

AIR INLET TIME DELAY CHECK

1. Connect air pressure supply hose to valve air inlet port (fig. 8).

2. Move the overtravel lever upward (quickly)

approximately two inches and simultaneously start counting the number of seconds before air starts to escape from bellows port. A delay of 2 to 9 seconds should exist. Repeat this check.

AIR EXHAUST TIME DELAY CHECK

To time the delay for exhaust, two methods can be used; one using vacuum source and one using air pressure.

1. Method Using Vacuum

a. Connect vacuum hose to air exhaust port (fig. 8). Adjust vacuum to 15 inches.

b. Move the overtravel lever downward (quickly) approximately two inches and simultaneously start counting the number of seconds before the vacuum gauge starts to drop off. A delay of 2 to 9 seconds should exist. Repeat this check.

2. Method Using Air Pressure

a. Install valve cover with new gasket on valve assembly.

b. Connect air pressure supply hose to bellows port (fig. 8).

c. Move overtravel lever downward (quickly) approximately two inches and simultaneously start counting the seconds before air starts to escape from the exhaust port. A delay of 2 to 9 seconds should exist.

IMPORTANT: A time delay over 9 seconds could mean too large a valve lever gap adjustment and a time delay under 2 seconds would mean too small a valve lever gap adjustment. If the time delay is not within 2 to 9 seconds, first recheck the fluid level. If fluid level is satisfactory, the valve lever gap adjustment must be repeated, step by step.

NOTE: After obtaining proper valve adjustments, install valve cover using new gasket. Install new screen in bellows port, then using new O-ring, install outlet adapter into bellows port. If screen was removed from exhaust port, install new screen and exhaust fitting. Install air line gaskets.

NOTE: Place tape over ends of air line ports until such time as valve assembly is installed on vehicle.

HEIGHT CONTROL VALVE OVERHAUL

Height control valves meter air into and out of the air suspension system. These valves are precision built and accurately adjusted. Parts must be carefully handled and assembled. Valves must also be accurately adjusted to insure proper operation after rebuild. Special tools mentioned previously should be used. Makeshift tools may break off chips that could lodge between valve and seats. Chips, dirt, and other foreign material could cause faulty valve operation.

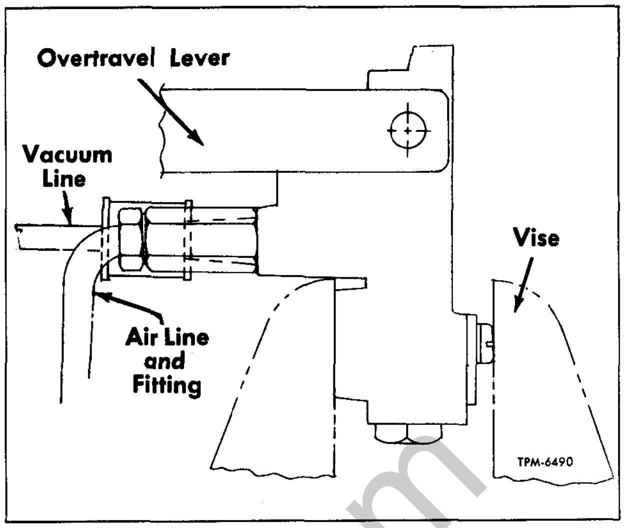


Figure 14—Valve Positioned For Time Delay Check

NOTE: Repair parts kit is available which contains all parts usually requiring replacement in average overhaul.

The following procedures cover disassembly, cleaning, inspection, and assembly of the valve. Take care to ensure cleanliness of all component parts before assembly.

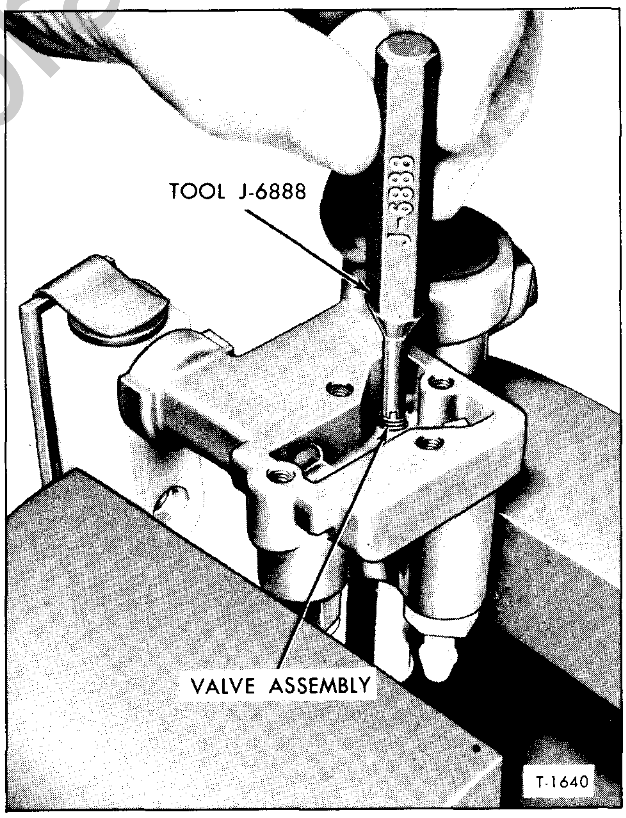


Figure 15—Replacing Valve Core Assemblies

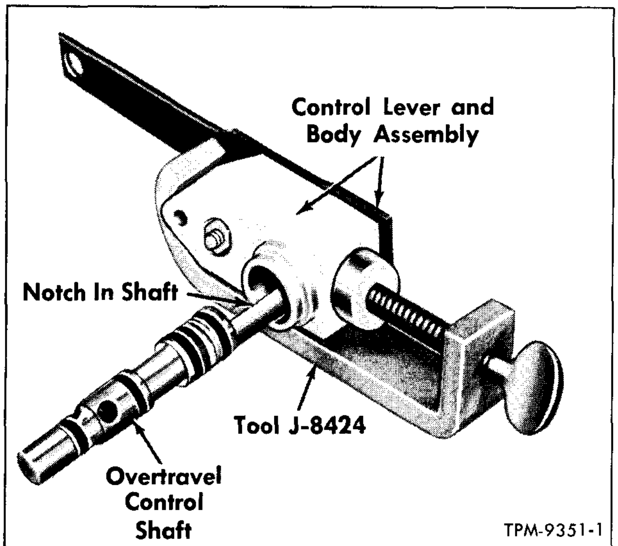


Figure 16—Replacing Overtravel Lever

DISASSEMBLY (Refer to Fig. 7)

1. Remove inlet adapter and check valve assembly (23) from valve body (8). Remove outlet adapter (24). Remove adapter O-rings (26). Remove air line fitting gasket (22) from adapters. Remove outlet adapter screen (25).
2. Remove four cover screws and lock washers (1) from cover and bracket (2). Remove cover and bracket and gasket (3).
3. Position valve with delay plug (30) at top. Unscrew delay plug from valve body (8). Drain silicone fluid from cavity. Remove plug O-ring (31). Unscrew piston pin (32) from control shaft (11).
4. Remove delay cover retainer (36), cover (35) and cover O-ring (34). Remove delay piston (33). Discard O-ring.
5. Remove valve lever screw and lock washer (4) from valve lever. Remove exhaust valve and intake valve lever (6) from valve body.
6. Remove valve stem lock clip (5) from stem of exhaust valve core. Spread locking arms and slide clip from around stem.
7. Pull overtravel assembly and shaft from valve body.
8. Remove intake valve core (7) with tool (J-6888) as shown in figure 15.
9. Remove exhaust fitting (27) and screen (28), then remove exhaust valve core (29) with tool (J-6888) as shown in figure 15.
10. Remove plug retainer (18) from overtravel control body (17). Retainer must be cut off. Use caution to avoid damage to nylon body. Remove overtravel body plug (13).
11. Place forked end of tool (J-8424) around shaft in overtravel control body, then tighten clamp screw. Refer to figure 16.

CAUTION

TIGHTEN TOOL UNTIL OVERTRAVEL CONTROL SHAFT (11) CAN BE TURNED 90° TO ALLOW NOTCH IN SHAFT TO PASS FREE OF OVERTRAVEL PISTON (14). DO NOT APPLY MORE PRESSURE THAN IS REQUIRED.

12. Remove overtravel control shaft (11) and overtravel control body seal (9) from body. Remove shaft O-rings (10 and 12). Back off vise jaw and take body and tool from vise. Remove tool, overtravel piston (14), overtravel lever large spring (15), and overtravel lever small spring (16) from body. Remove lever screw nut (19) from overtravel lever screw or stud. Remove lever (20) from body.

CLEANING AND INSPECTION

1. The following parts should be discarded and replaced with new parts at each overhaul: Plug retainer (18), overtravel control body seal (9), gasket (3), and O-rings (10, 12, 26, 31, and 34).
2. Thoroughly clean all metallic parts in a suitable cleaning solvent. Blow parts dry with compressed air.
3. Inspect all bearing and rubbing surfaces for scoring, fractures, or noticeable wear. Discard all damaged or worn parts and replace with new parts.

ASSEMBLY

CAUTION: HEIGHT CONTROL VALVE PARTS MUST BE KEPT FREE FROM DIRT AND MOISTURE.

1. Install intake valve core (7) and exhaust valve core (29) with screen (28) in control body (8) as shown in figure 15. Tighten to proper torque. Install exhaust fitting (27).
2. Lubricate overtravel control body with multi-purpose grease. Assemble overtravel components as follows:
   a. Install overtravel lever (20) on control body. Place lever stud nut (19) on stud and tighten to torque listed in "Specifications" at end of this section.
   b. Place overtravel lever large spring (15), and overtravel lever small spring (16) inside piston (14). Insert piston in control body (17).
   c. Place three new O-rings (10 and 12) on overtravel control shaft (11). Lubricate shaft and O-rings with multi-purpose grease.
   d. Position fork of tool (J-8424) so that shaft can be inserted in body. Carefully apply pressure with clamp screw (fig. 16). Compress springs only enough to allow shaft to be inserted. Install over-

travel control shaft (11). Rotate shaft so that flat is next to piston, and remove tool (J-8424).

e. Insert overtravel body plug (13) in bore of body. Force new plug retainer (18) in position over nylon pivot and body plug (13).

f. Place new overtravel control body seal (9) on shoulder of body. Slide overtravel assembly into valve body (8). Insert carefully to avoid seal damage.

3. Install time delay assembly as follows:

a. Place delay piston (33) in valve body with open side of piston toward the overtravel shaft (11).

b. Align pin openings in piston and in shaft. Fit piston pin (32) in TAPERED SIDE of hole in shaft. Tighten pin to torque listed in "Specifications" at end of this section.

4. Place intake valve and exhaust valve lever (6) in position on overtravel shaft. Make sure the fork on the exhaust lever side is around stem of exhaust valve core (29). Fork should be high enough on stem so that stem will not be held open. Insert valve lever screw (4) and tighten to torque listed in "Specifications" at end of this section.

5. Spread ends of valve stem lock clip (5) slightly and place on exhaust valve stem around stem head. Use suitable tool to brace stem and pinch ends of clip just enough to secure on stem. Clip must rotate freely on stem.

6. Using new O-ring (26), install air inlet adapter and check valve assembly (23) into valve body.

7. Make all of the valve assembly adjustments explained under "Height Control Valve Adjustments" on pages earlier in this section.

REYCO TORQUE SPECIFICATIONS

REYCO	FT. LBS.
Spring Hanger Bracket To Frame (All)	50-60
Radius Leaf Rod Eyebolt Nut	200
Spring to Axle U-Bolt Nut	300
Equalizer Arm to Hanger Nut	500

REAR SUSPENSION SPECIFICATIONS

VARI-RATE REAR SPRINGS		
TORQUE ROD BUSHING (RUBBER)		
O.D.	1.688″	1.693″
I.D.	0.940″	0.947″
LGT	3.225″	3.250″
RADIUS LEAF ROD BUSHING (BRONZE)		
O.D.	1.506″ installed	*1.508″
I.D.	1.245″ installed	*1.247″
LGT	2.90″ ±	.015″
MAINLEAF EYE BUSHING (BRONZE) HM-80		
O.D.	1.680″ installed	*1.682″
I.D.	1.419″	1.421″
LGT	2.97″ ±	.05″
RADIUS LEAF ROD BUSHING—(RUBBER)		
O.D.	1.815″	1.821″
I.D.	1.002″	1.009″
LGT	3.215″	3.240″
RADIUS LEAF PIN		
O.D.	1.249″	1.250″
LGT		4.68″
MAIN SPRING EYE BOLT HM-80		
O.D.	0.929″	0.936″
LGT	4.88″ ±	.00-.09″
HENDRICKSON TANDEM SUSPENSION		
Spring Eye Bushing		
I.D.	1.247″ installed	*1.253″
O.D.	1.498″	1.501″
LGT		3.96″
Spring Eye Pin (O.D.)	1.247″	1.248″
LGT		7³⁄₁₆″

*Ream at assembly.

TORQUE SPECIFICATIONS

VARI-RATE REAR SPRINGS	TYPE OF PART	TORQUE (FT.-LBS.)
Rear Spring U-bolt		
Conventional models and TM-80	Nut	190-210
Alum. Tilt Series	Nut	220-250
Radius Leaf Eyebolt To Hanger		
Alum. Tilt Series	Nut	150-200
TM-80	Nut	290-320
Torque Rod Eyebolt To Hanger	Nut	150-200
Rear Spring Bumper Bolt	Nut	10-15
TM-80 Bolt	Nut	8-12
Pin Retainer To Spring Hanger	Bolt	20-25
Rear Spring Radius Leaf Pin Clamp Bolt	Nut	25-30
Rebound Pin Bolt	Nut	30-35
Rebound Pin Retainer Frame Lock	Bolt	25-30
Front Spring Pad Bracket To Frame Bolt		
Conventional 70-90 Alum. Tilt Series	Nut	50-60
Spring Hanger To Side Rail Bolt (Front)	Nut	90-110
Spring Hanger To Side Rail Bolt (Rear)	Nut	40-50
Shock Absorber Mounting Stud (Upper and Lower)	Nut	70-80

HENDRICKSON (Series RU)

Spring Saddle Top Pad U-Bolt	Nut	275-300
Spring Saddle Cap to Saddle*	Bolt	310-340
Rear Spring Front Pin Lock Bolt	Nut	30-40
Rear Spring Rear Rebound Bolt	Nut	40-50
Spring Bracket and Spacer to Side Rail Bolt*	Nut	90-100
Equalizing Beam End Adapter	Bolt	330-350
	Nut	190-210
Bumper Stop to Frame	Bolt	100-120
Torque Rod to Axle Housing Stud	Nut	120-150
Torque Rod Bracket to Crossmember Bolt	Nut	40-50
Torque Rod and Bracket to Crossmember Bolt	Nut	90-100

*Lubricate Bolt Threads with SAE #20 oil before tightening.

HENDRICKSON (Series RT)

Spring Saddle Top Pad Bolt	Nut	275-300
Spring Saddle Cap Stud	Nut	275-300
Spring Saddle Top Pad Set Screw	—	100-150
Rear Spring Rear Rebound Bolt	Nut	40-50
Rear Spring Front Pin Lock Bolt	Nut	40-50
Equalizing Beam End Adapter	Bolt	350-370
	Nut	190-210
Torque Rod to Axle Housing Stud	Nut	110-120
Torque Rod Bracket to Side Rail Lower Flange Bolt	Nut	40-50
Torque Rod Bracket to Crossmember	Bolt	100-120
	Nut	40-50

PAGE AND PAGE (LWH)	TYPE OF PART	TORQUE (FT.-LBS.)
Pedestal and Spacer to Frame Lower Flange	Bolt	100-120
	Nut	40-50
Pedestal to Frame Bolt:		
½" x 20 x 2¼" (4)	Nut	40-50
⅝" x 18 x 2¼" (12)	Nut	90-100
Rear Axle Torque Rod Bracket to Crossmember Bolt	Nut	40-50
Torque Rod and Bracket to Crossmember Bolt	Nut	90-110
Torque Rod Bracket to Frame	Nut	45-55
Torque Rod to Axle Housing Stud	Nut	120-150
Bump Stop to Frame	Bolt	100-120
	Nut	40-50
Cross Tube to Pedestal Bolt	Nut	190-210
Cross Tube End Adapter Retaining Bolt	Bolt	330-350
	Nut	190-210
Cross Tube to Spring Cap U-Bolt	Nut	550-600
Compression Cap Retaining Bolt	Bolt	500 (min.)
Insulator Cap to Rocker Arm U-Bolt	Nut	220-250
Rocker Arm-to-Axle Bracket Adapter Bolt		330-350
Rocker Arm-to-Axle Bracket Adapter Bolt	Nut	190-210

PAGE AND PAGE 800 SUSPENSION SYSTEM

Front Spring U-Bolt		300-330
Spring Rebound Roller Bolt (Front or Rear)	Nut	100-120
JI, MI90	Nut	50-60
Rocker Arm Bracket-to-Frame Bolt	Nut	40-50
JI, MI90	Nut	30-40
Compression Cap to Bracket Lock	Bolt	120-130
JI, MI90	Bolt	80-90
Compression Cap Retaining Bolt	Nut	115-125
Compression Spring Eye Bolt Lock	Bolt	10-15
Spring Eye Compression Bolt	Nut	90-110
Front Spring Front Hanger to Frame	Nut	30-40

AIR SUSPENSION TORQUE SPECIFICATIONS

	TYPE OF PART	FOOT-POUNDS TORQUE
Lower Control Arm to Frame Bracket Pivot Bolt	Nut	490-520
Frame Bracket to Frame Bolt	Nut	190-210
Bellows Support Bracket to Control Arm Bolt	Nut	190-210
Bellows to Support Bracket Stud	Nut	8-12
Bellows Upper Support Bracket to Frame Bolt	Nut	50-60
Lower Control Arm Bracket to Lower Axle Anchor Plate Bolt	Nut	490-520
Suspension Air Tank "U" Bolt	Nut	12-16
Height Control Valve Link Stud	Nut	5-8
Height Control Valve Bracket to Frame Bolt	Nut	8-12
Height Control Valve to Mounting Bracket Bolt	Nut	3-5
Shock Absorber Upper and Lower Mounting Bolt	Nut	70-80
Shock Absorber Upper Bracket to Frame Bolt	Nut	90-110

REAR HUBS AND BEARINGS

DESCRIPTION

Rear hubs are mounted on axle housing tube on opposed tapered roller bearings as shown in figures 2 and 3. Hubs, bearings, and oil seals illustrated in figures 2 and 3 are identified with type of rear axle. Refer to "Protect-O-Plate" in Owner Protection Plan booklet to determine type of axle used on a specific vehicle.

Mounting parts (mainly bearings, adjustment and lock nuts, seals, and sleeves) shown in figures 2 and 3 are of primary importance. Brake drum mounting bolts, studs, and nuts differ in type and method of installing on various series vehicles.

New hub oil seals should be installed when servicing bearings if there is the slightest indication of wear or damage. An imperfect seal may permit bearing lubricant to reach brake linings, resulting in faulty brake operation and necessitating premature replacement of linings.

BEARING ADJUSTMENT CHECK

Before checking wheel bearing adjustment, make sure brakes are fully released and do not drag. Jack up axle until tires clear floor; then remove axle shafts as directed in "REAR AXLES" (SEC. 4A).

Check bearing end play by grasping tire at top and pulling back and forth, or by using a pry bar under tire. If bearings are properly adjusted, movement of brake drum in relation to backing plate or brake spider will be barely noticeable and wheel will turn freely. If movement is excessive, adjust as directed under "Wheel Bearing Adjustment" following:

WHEEL BEARING ADJUSTMENT

1. Jack up rear axle and remove axle shaft as directed in "REAR AXLES" (SEC. 4A).
2. On vehicles using outer oil seal and outer oil seal sleeve, remove the seal from axle shaft flange studs.
3. Remove bearing lock nut and nut lock.
4. While rotating the hub and drum assembly in both directions to seat bearings properly in recesses of hub, tighten the adjusting nut to 50 foot-pounds torque.
5. Back off the adjusting nut 1/4 to 1/3 turn to assure 0.001" to 0.007" end play.
6. Install bearing adjusting nut lock, referring to figure 1.
   a. If vehicle is equipped with type shown in View A, figure 1, align flat on adjusting nut with nearest lip of nut lock. Make sure wheel turns freely; then install nut lock and lock nut. Tighten lock nut to 100-150 foot-pounds. Bend one lip of nut lock over one flat on each nut.
   b. If vehicle is equipped with type shown in View B, figure 1, align dowel pin of adjusting nut with nearest hole in lock ring. Lock ring may be turned on either side to facilitate alignment of hole with least movement of adjusting nut beyond 1/4 to 1/3 turn. Install lock nut and tighten to 250 to 300 foot-pounds torque.
7. After completing bearing adjustment, recheck adjustment to make sure wheel turns freely. Final bearing adjustment should provide within 0.001" to 0.007" end play.
8. On vehicles using outer oil seal and sleeve, install the seal over rear axle shaft flange studs.
9. Install axle shaft as directed in "REAR AXLES" (SEC. 4A).

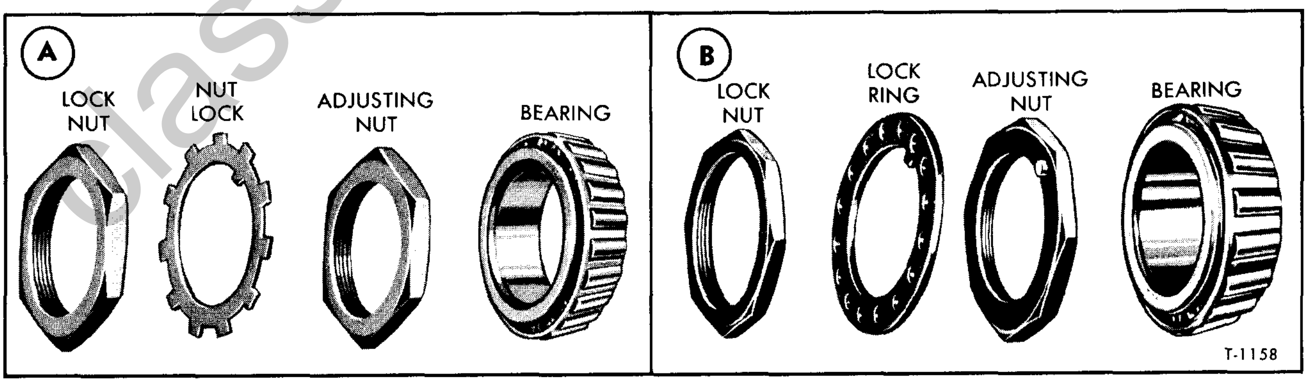
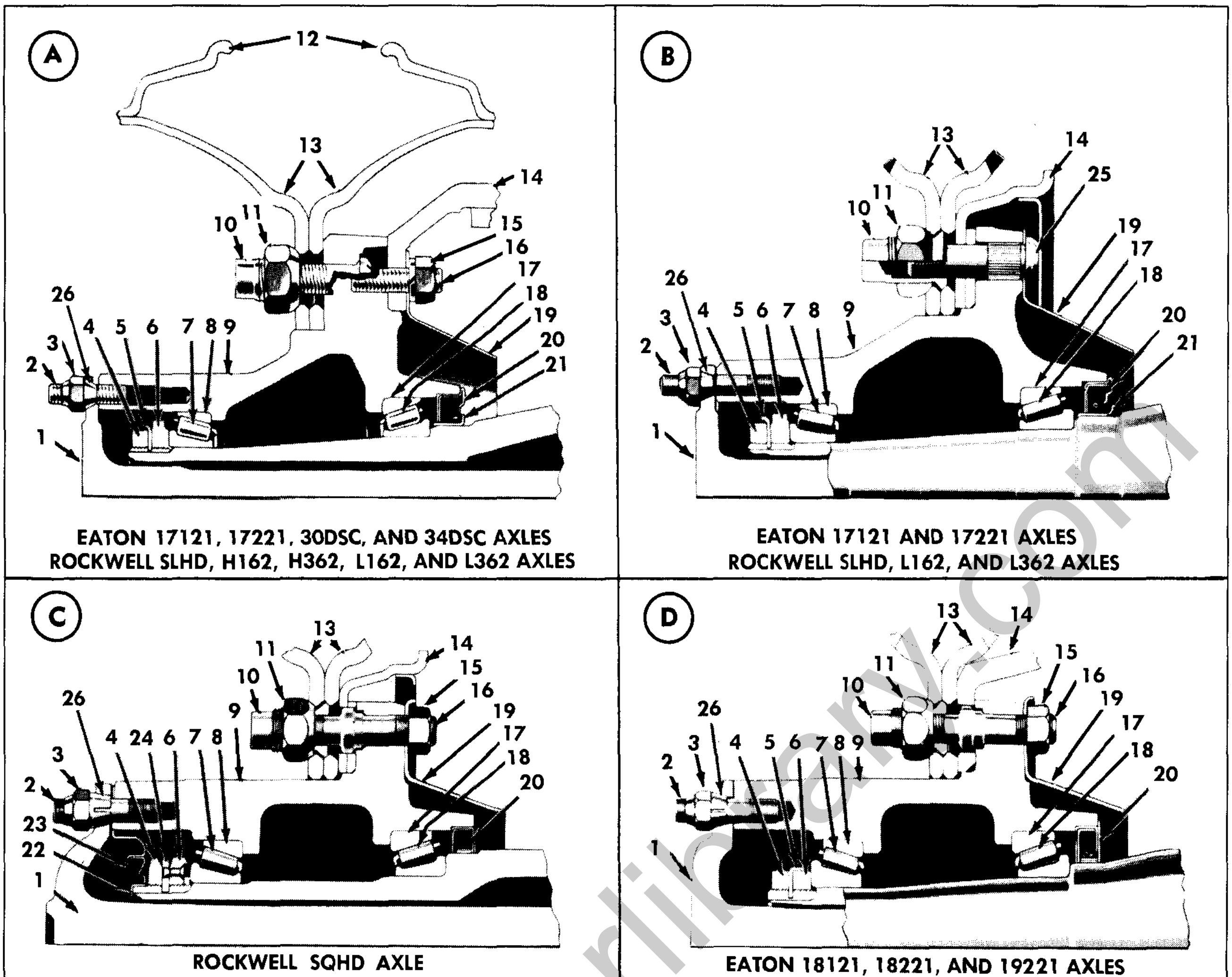


Figure 1—Rear Wheel Bearing Adjustment Nuts



1 Axle Shaft
2 Shaft to Hub Dowel
3 Lock Nut
4 Lock Nut
5 Nut Lock
6 Bearing Adjusting Nut
7 Outer Bearing Cone and Rollers
8 Outer Bearing Cup
9 Hub
10 Inner Nut
11 Outer Nut
12 Wheel Rims
13 Wheel
14 Brake Drum
15 Nut
16 Stud
17 Inner Bearing Cup
18 Inner Bearing Cone and Rollers
19 Oil Shield
20 Inner Oil Seal
21 Oil Seal Sleeve
22 Outer Oil Seal Wiper
23 Outer Oil Seal
24 Lock Ring
25 Bolt
26 Dowel

T-6857

Figure 2—Rear Hubs and Bearings (with Disc-Type Wheels)

HUB, BEARING AND OIL SEAL REPLACEMENT

REMOVAL (Figs. 2 and 3)

1. Jack up rear axle and remove tire and rim assembly on vehicles having cast wheels. Remove tire and wheel assembly from vehicles having disc wheels.
2. If brake drum is demountable type, remove brake drum.
3. Remove rear axle shaft as described in "REAR AXLES" (SEC. 4A).
4. On vehicles using outer oil seals, remove oil seal and sleeve from axle shaft flange studs.
5. Remove lock nut, nut lock, and adjusting nut from axle housing tube.
6. Lift the wheel (hub) and drum assembly or the hub straight off axle housing. Use care to prevent outer bearing cone and roller assembly from dropping on floor. Remove outer bearing assembly.

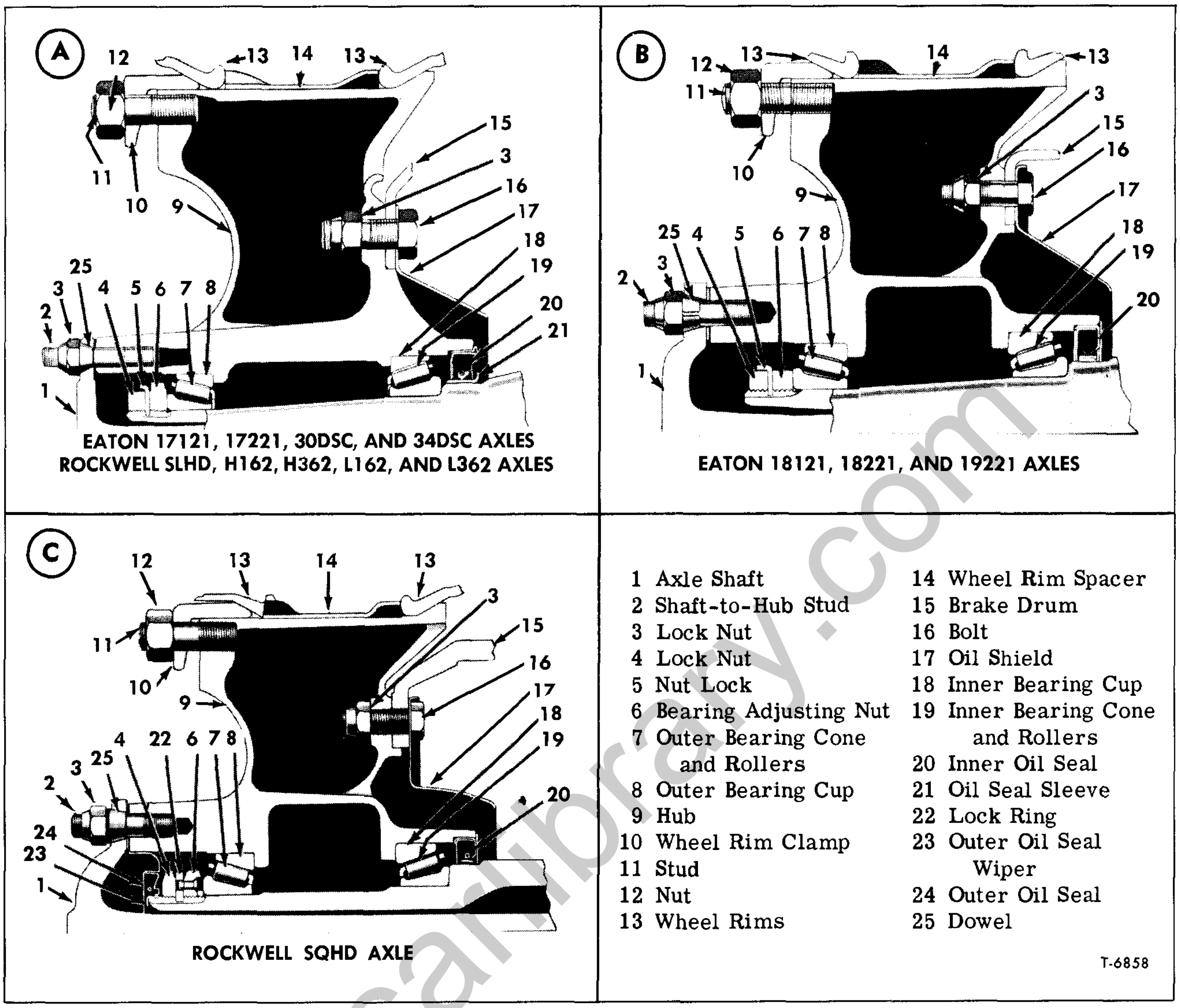


Figure 3—Rear Hubs and Bearings (with Cast-Type Wheels)

7. Remove inner oil seal from wheel (hub) and drum assembly; then remove inner bearing cone and roller assembly from hub. Discard oil seal.

8. Clean, inspect, and repair parts as described later in this section.

INSTALLATION (Figs. 2 and 3)

After completing "Cleaning, Inspection, and Repair" operations described later in this section, lubricate bearings, axle housing tube, and inside of hub as described in LUBRICATION (SEC. 0) of this manual. Coat lip of inner oil seal and surface contacted by lip with wheel bearing grease or equivalent.

1. Position inner bearing cone and roller assembly in hub or wheel (hub) and drum assembly. Coat oil seal bore in hub with a thin layer of non-hardening sealing compound.

2. Using suitable tools, install oil seals as follows:

a. Press seal into hub until shoulder is against outer edge of hub. Lip of oil seal goes into hub first (see figs. 2 and 3).

b. Wipe excess sealing compound out of hub. Make sure no sealing compound gets on lip of oil seal.

3. Make sure oil seal sleeve (if used), is in place on axle housing tube.

4. Install wheel hub and drum assembly or hub assembly on axle housing tube. Use care not to damage the inner oil seal.

5. Place outer bearing cone and roller assembly on axle housing tube and press firmly into place with fingers. Install bearing adjusting nut.

6. Install brake drum (if removed). Install tire and rim assembly or tire and wheel assembly.

Adjust bearings and complete the installation as previously described under "Wheel Bearing Adjustment."

7. Install axle shafts as directed in "REAR AXLES" (SEC. 4A).

CLEANING, INSPECTION, AND REPAIR

CLEANING

Immerse all parts, including bearing assemblies, in cleaning solvent. Clean bearings with a stiff brush. Blow bearings dry with compressed air, directing air stream across bearings. Do not spin bearings while blowing them dry.

INSPECTION

1. Inspect bearings for excessive wear, chipped edges, or other damage. Slowly roll rollers around cone to detect any flat or rough spots. If either the cone and roller assembly or the cup of the roller bearings are damaged, the complete bearing assembly must be replaced.
2. Examine bearing cups which are still installed in hub. If cups are pitted or cracked, they must be replaced as directed later under "Repair."
3. Examine oil seal sleeve (when used) on which the hub inner oil seal lip wipes for evidence of wear or roughness. If any damage is evident, sleeve must be replaced. Oil seal sleeves are replaced as directed later under "Repair."
4. Inspect axle shaft flange studs for damaged threads or bent condition. Replace studs as necessary.
5. Examine brake drums for scoring or other damage. Non-demountable brake drums can be refinished while mounted on hubs. If necessary to replace brake drum refer to "Repair" later in this section.
6. Examine wheel bolts or studs and rim clamp studs for damaged threads and replace, if necessary, as directed later under "Repair."
7. Discard old oil seals and obtain new oil seals to be used at assembly.

REPAIR

Bearing Cup Replacement

1. Bearing cups are removed by using a mild steel rod through opposite end of hub and driving against inner edge of bearing cup. Alternately drive on opposite sides of cup to avoid cocking cup and damaging inside of hub.
2. To install new cups, position cup in hub and drive into place, using a mild steel rod against outer edge of cup. Alternately drive against opposite sides to assure driving cup in squarely. Cups must seat firmly against shoulder in hub.

Inner Oil Seal Sleeve Replacement

1. To remove oil seal sleeve, tap sleeve around entire circumference with hammer to stretch the metal; then use a blunt chisel to cut into the sleeve inner flange. This will loosen the sleeve sufficiently to permit removal.

NOTE: Be careful not to damage axle tube when chiseling on sleeve.

2. Slide new sleeve over axle housing tube; then using axle oil seal sleeve driver set J-3822-02, drive sleeve into place. Use care not to damage surface on sleeve contacted by inner oil seal.

Brake Drum Replacement

1. Remove bolts and lock nuts, or studs and nuts attaching brake drum to hub.
2. Remove brake drum and oil shield or deflector (if used) from hub.
3. Apply Permatex between oil shield or deflector (if used) and brake drum.
4. Position brake drum and oil shield or deflector on hub, aligning all drain holes.
5. Install bolts and lock nuts or studs and nuts attaching brake drum to hub. Tighten attaching parts securely.

IMPORTANT: If any wheel experiences a single stud failure caused by a loose-running wheel all studs should be replaced.

A loose running wheel may cause only one stud to break, but several more studs may become fatigued to the point of failure, but not actually breaking. Replacing only the one broken stud and remounting wheel will then set the stage for a second and possibly more serious failure. If holes in wheel have become elongated or enlarged, replace wheel.

Wheel Bolt Replacement

Wheel bolts are serrated and pressed into hub flange. To replace bolts, press bolts out of hub flange. Press new bolts into place, making sure they are a tight fit. If all bolts are removed, be sure oil shield or deflector (when used) is in place under bolt heads before installing new bolts.

Rim Clamp Stud Replacement

Rim clamp studs can be removed and replaced by using a conventional stud remover and replacer tool. When installing new studs, make sure studs are firmly bottomed in tapped holes and that threads are not damaged during installation.

Outer Oil Seal Wiper Sleeve Replacement

The outer oil seal wiper sleeve is pressed on outer end of axle housing tube (C, fig. 2, and C, fig. 3). If the sealing surface of a wiper sleeve is damaged, install a new sleeve. Make sure that wiper seats squarely and that sealing surface on sleeve is not damaged in any way.

PROPELLER SHAFTS

DESCRIPTION

Power is transmitted from transmission to rear axle through one or more propeller shaft and universal joint assemblies. The number of propeller shafts and universal joint assemblies vary with vehicle wheelbases and combinations of transmission and rear axle equipment. Some typical arrangements are shown in figure 1.

All propeller shafts are tubular type. A splined slip joint is provided in each drive line. If a single propeller shaft is used, slip joint is at transmission end of shaft; if two or more shafts are used, slip joint is at forward end of rear shaft. End of slip yoke is sealed by a felt or cork washer, held in place by a steel washer and a dust cap which threads onto end of yoke. Fixed yoke may be either welded to propeller shaft tube as shown in figures 3 and 4, or it may be splined to a stub shaft and secured with a nut and cotter pin as shown in View A, figure 6. Alignment arrows on slip yoke and shaft provide for alignment of yokes at assembly.

NOTE: Refer to "Service Diagnosis Chart" on following page when servicing propeller shafts.

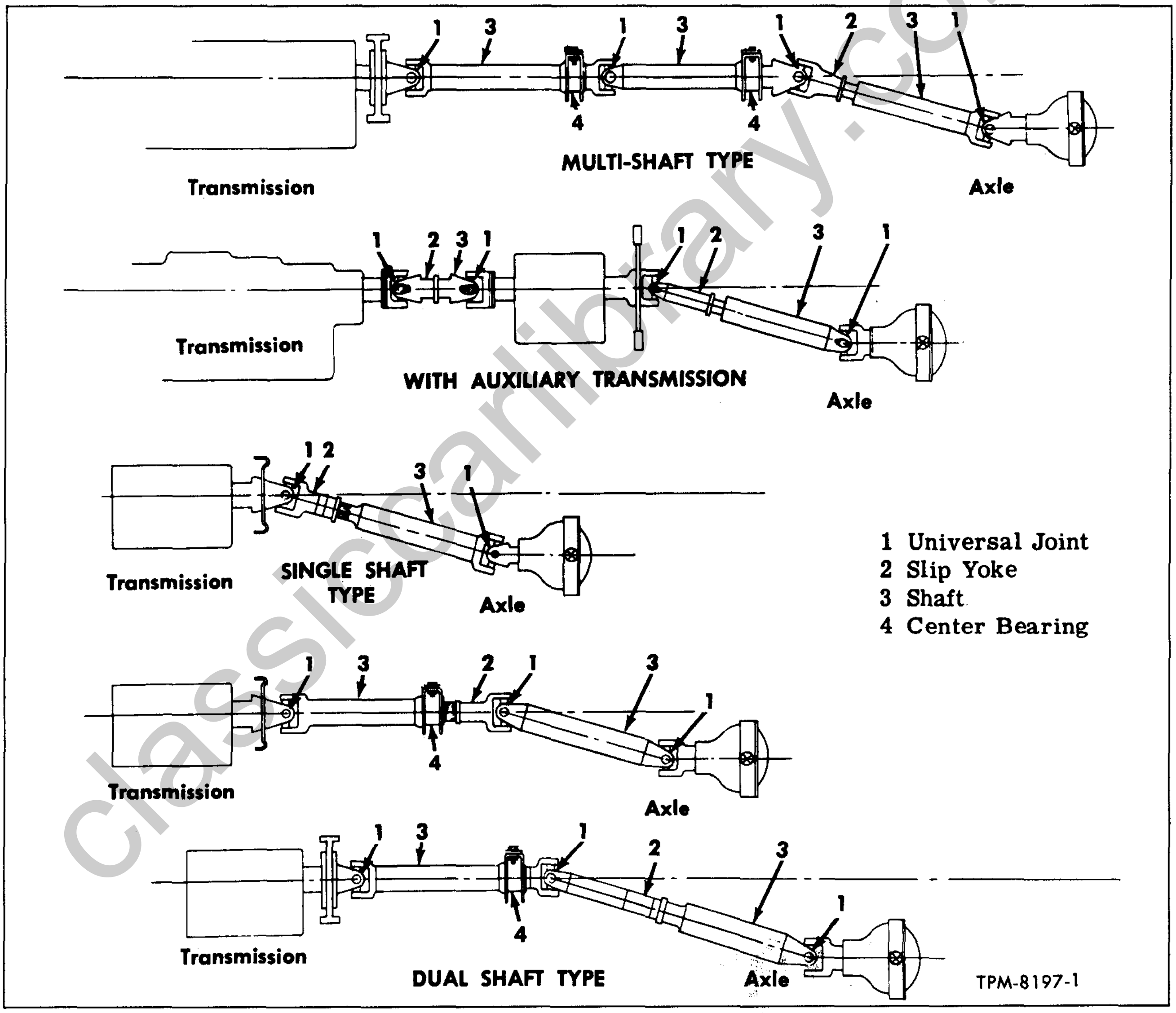


Figure 1—Typical Propeller Shaft Combinations

SERVICE DIAGNOSIS CHART

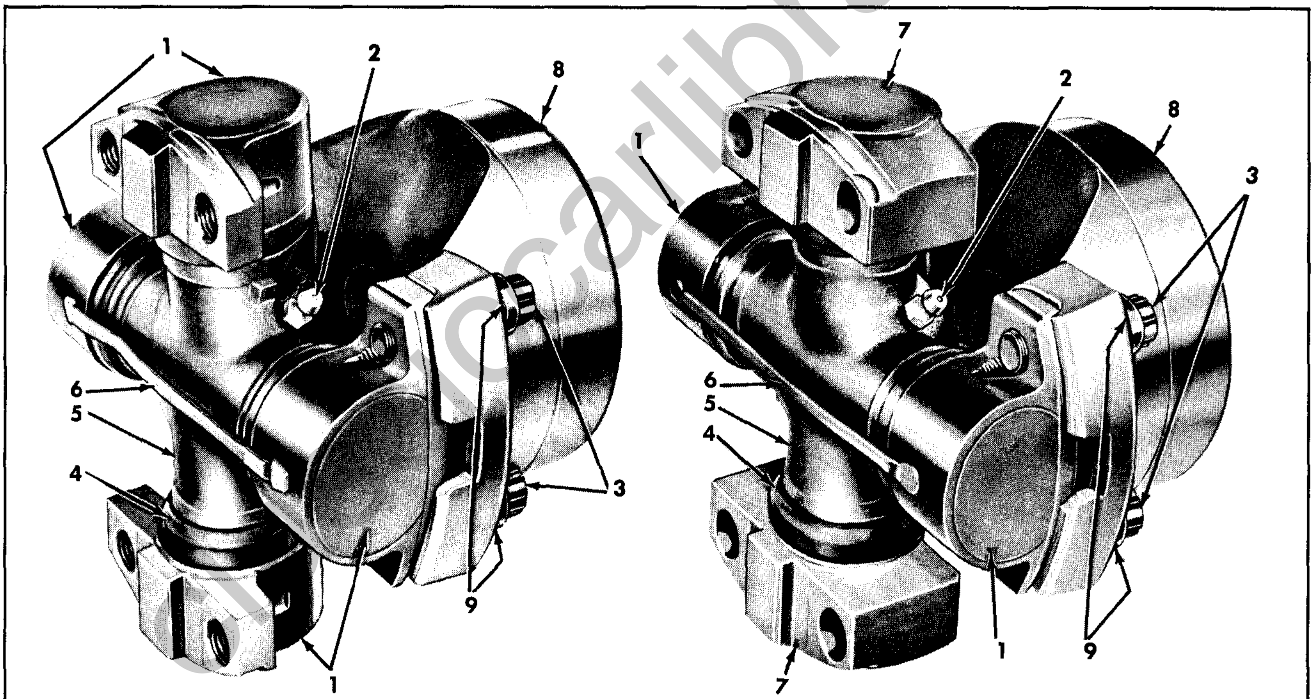
CONDITION	POSSIBLE CAUSE	CORRECTION
Propeller Shaft Vibration	1. Propeller Shaft Out of Balance.	1. Check for Foreign Material on Propeller Shaft.
	2. Parking Brake Drum Out of Balance.	2. Replace Drum.
	3. Distorted or Damaged Yokes.	3. Install New Yokes.
	4. Yokes Out of Parallel to Each Other.	4. Change Propeller Shaft.
Universal Joint Noise	1. Center Bearing Worn.	1. Replace Center Bearing.
	2. Worn Universal Joint Bearings.	2. Replace Bearings.
	3. Improper Lubrication.	3. Lubricate as Directed.
	4. Loose Flange Bolts.	4. Tighten to Specifications.

UNIVERSAL JOINTS

Six types of universal joint assemblies are used on vehicles covered by this manual. The joint assemblies are 1410, 1480, 58WB, 68WB, 1700 and 1800.

NOTE: The 68WB universal joint is used with auxiliary transmission. Refer to "Specifications" at end of this section for type of joint used at various locations on any vehicle with standard equipment. Refer to "Parts Book" for universal joint application with optional transmission and axles. Universal joints are described below:

Type 58WB and 68WB (Figs. 2 and 3). Needle rollers are installed in bearing cages which have integral mounting flanges (wings). Bearing cages are attached to mating flanges with special cap screws and lock washers. On low-ring bearings, holes in mounting flanges are threaded, and the attaching cap screws thread into the mounting flange. On high-wing bearings, the holes in the



1 Low Wing Bearing (Threaded)
2 Lubrication Fitting
3 Special Cap Screw
4 Oil Seal
5 Journal
6 Tie Bar
7 High Wing Bearing (Not Threaded)
8 Propeller Shaft Yoke
9 Lock Washer

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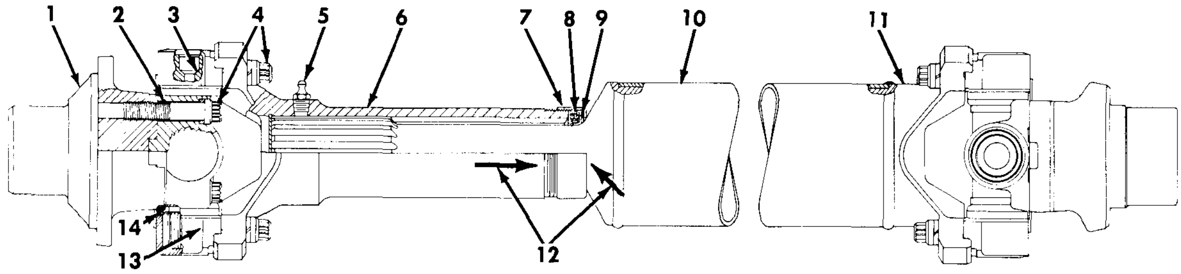
Figure 2—Type 58WB and 68 WB Universal Joint Showing High and Low Wing Bearings



1 Flange Yoke
2 High Wing Bearing
3 Journal
4 Special Cap Screws
5 Lubrication Fitting
6 Slip Yoke
7 Dust Cap
8 Washer (Felt)
9 Washer (Steel)
10 Propeller Shaft
11 Flange Yoke
12 Alignment Arrows
13 Low Wing Bearing
14 Oil Seal

TPM-8227

Figure 3—Typical Propeller Shaft with 58WB and 68WB Universal Joints

mounting flange are not threaded; the attaching cap screws pass through the mounting flange and thread into the mating flange. An oil seal is installed on inner end of each bearing cage. Tie-bars, shown in figure 2 are to retain bearings on journal cross during storage and can remain in place during operation; however, the tie-bar must be cut to permit disassembly of joint.

Types 1410 and 1480 (Fig. 4). Joint bearing cages are retained in yoke flanges on propeller shaft by snap rings. Bearings at opposite end of propeller shaft are attached to journal cross with snap rings and U-bolts, lock washers and nuts. A visual inspection must be made of vehicle to determine at which end of propeller shaft U-bolts and lock rings are used and at which end of propeller shaft lock rings only are used. Needle rollers are installed in bearing cages and oil seals are installed on inner ends of cages.

Repair Kits

Universal joint repair kits are available for all types of universal joints. Each kit contains a journal, bearings and seals, and retaining components which should always be replaced when overhauling a universal joint.

CENTER BEARING (Fig. 6)

Center bearings are used to support center portion of drive line when two or more propeller shafts are used. Bearing is ball type, mounted in a rubber cushion which is attached to frame crossmember by the center bearing support. The two center bearings shown in cross section in figure 6 are of the same construction except for shape and location of dust slingers. View B illustrates center bearing used at shaft end with slip yoke; View A illustrates center bearing used at shaft end with fixed yoke. Bearing is prelubricated and permanently sealed. Cavities in grease retainers on both sides of bearing are packed with waterproof grease to exclude dirt and water.

LUBRICATION

Journals of universal joints are drilled and provided with lubrication fittings through which lubricant travels to all four oil reservoirs, then through a small hole in side of each reservoir, direct to needle bearings. Needle bearings are protected against lubricant leakage and entrance of foreign matter by seals. Splines of slip joint are lubricated through lubrication fitting installed in slip yoke.

NOTE

Universal joints and slip yoke splines should be lubricated periodically as specified in LUBRICATION (SEC. 0) of this manual.

PROPELLER SHAFT REMOVAL

Disconnecting propeller shaft permits removal of transmission or rear axle without disturbing unit at other end of shaft. On some vehicles, propeller shaft may be removed at any flange joint by removing nuts from bolts holding flange. On other vehicles, propeller shafts must be disconnected at universal joints as described later in this section.

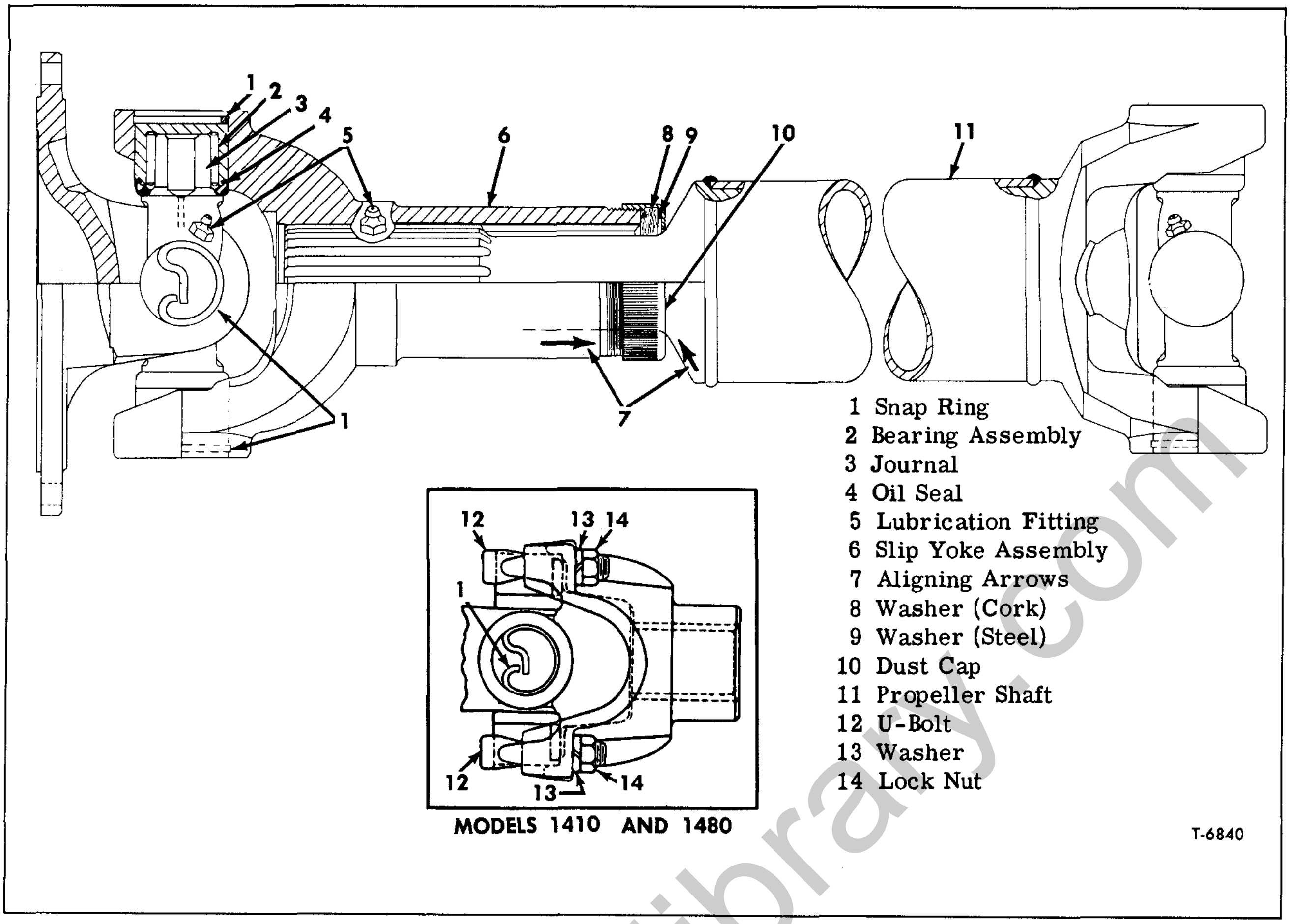


Figure 4—Typical Propeller Shaft with Type 1410 and 1480 Universal Joints

Propeller shaft should be supported before removing to prevent damage by dropping. To remove complete drive line on models in which center bearings are used, it is necessary to disconnect center bearing support from crossmember.

DISASSEMBLY OPERATIONS

SLIP JOINT DISASSEMBLY

With propeller shaft removed, look for arrow marks on propeller shaft and slip yoke as shown in figures 3 and 4. If both marks are not clearly discernible, punch mark both members to insure assembly in exactly same relative position. When clearly marked, unscrew dust cap and withdraw shaft. Remove cork or felt washer, steel washer, and dust cap from shaft.

UNIVERSAL JOINT DISASSEMBLY

Types 58WB and 68WB (Figs. 2 and 3)

Remove special cap screws and lock washers attaching bearing cages on opposite ends of journal to mating flange. Cut welded tie bar, then remove bearing assemblies from journal.

Types 1410 and 1480 (Fig. 4)

1. On universal joints using snap rings to retain bearings on journal cross, remove snap rings (fig. 4).
2. On universal joints using U-bolts or self locking bolts to retain bearings on journal cross, remove nuts and washers from U-bolts, then remove U-bolts. If self locking bolts are used, remove bolts.
3. Strike one side of yoke with hammer to force one bearing out of yoke. Strike opposite side of yoke to force opposite bearing out.

CAUTION: Use care to prevent bearings from dropping on floor as irreparable damage may result.

4. Journals can now be tilted to permit removal of yoke from journal.
5. Remove the other two bearings in the same manner to permit removing journal.

TYPES 1700 AND 1800 (Fig. 5)

1. Bend tangs of lock straps away from cap screw heads. Remove cap screws and lock straps securing bearings in yokes.
2. Strike one side of yoke with soft hammer to force one bearing out of yoke. Strike opposite side of yoke to force out opposite bearing.
3. Journals can now be tilted to permit removal of yoke from journal.
4. Remove the other two bearings in the same manner to permit removing journal.

CENTER BEARING DISASSEMBLY

The following procedure covers disassembly of center bearing with propeller shaft removed from vehicle. Key numbers in text refer to figure 6.

1. Remove retainer (5) from support (6), then remove support from cushion (4).
2. On type shown in View A, figure 6, remove cotter pin and nut securing yoke (2) on shaft, then pull yoke off shaft. On type shown in View B, remove dust shield (11) from shaft.
3. Remove rubber cushion (4) from bearing (9), then pull bearing assembly from shaft.
4. Remove grease retainers (7) from bearing, and remove slingers (8).

IMPORTANT: Do not attempt to disassemble ball bearing. This is a sealed bearing and cannot be disassembled without being destroyed.

5. If dust shields (3) are damaged, use a chisel to break welds and remove shields.

CLEANING AND INSPECTION

PROPELLER SHAFT

Thoroughly clean old grease and dirt from shaft splines, then check splines for wear, warpage, and cracks. If shaft is worn, warped, or cracked, replace with new shaft. Welding of broken shaft is not recommended, since this operation requires special balancing facilities.

UNIVERSAL JOINT

Wash all parts in cleaning fluid. Make sure lubricant passages in journal cross are clean.

Soak needle bearings and cages in cleaning fluid to soften particles of hardened grease, then wash in cleaning fluid, using a stiff brush if necessary to remove all old lubricant. Check each bearing for missing rollers. Refer to "Specifications" at end of this section for correct number of rollers. After needle bearing assemblies are thoroughly clean, apply clean lubricant to rollers and turn on trunnion of journal to check wear. Refer to LUBRICATION (SEC. 0) for type of lubricant. If excessive clearance is noted, discard journal and bearings and replace with new parts contained in universal joint repair kit.

SLIP JOINT

Using a suitable cleaning fluid, clean all dirt and old grease from slip yoke, slip yoke splines, and shaft splines. Carefully inspect slip yoke splines for wear or evidence of twisting. Check

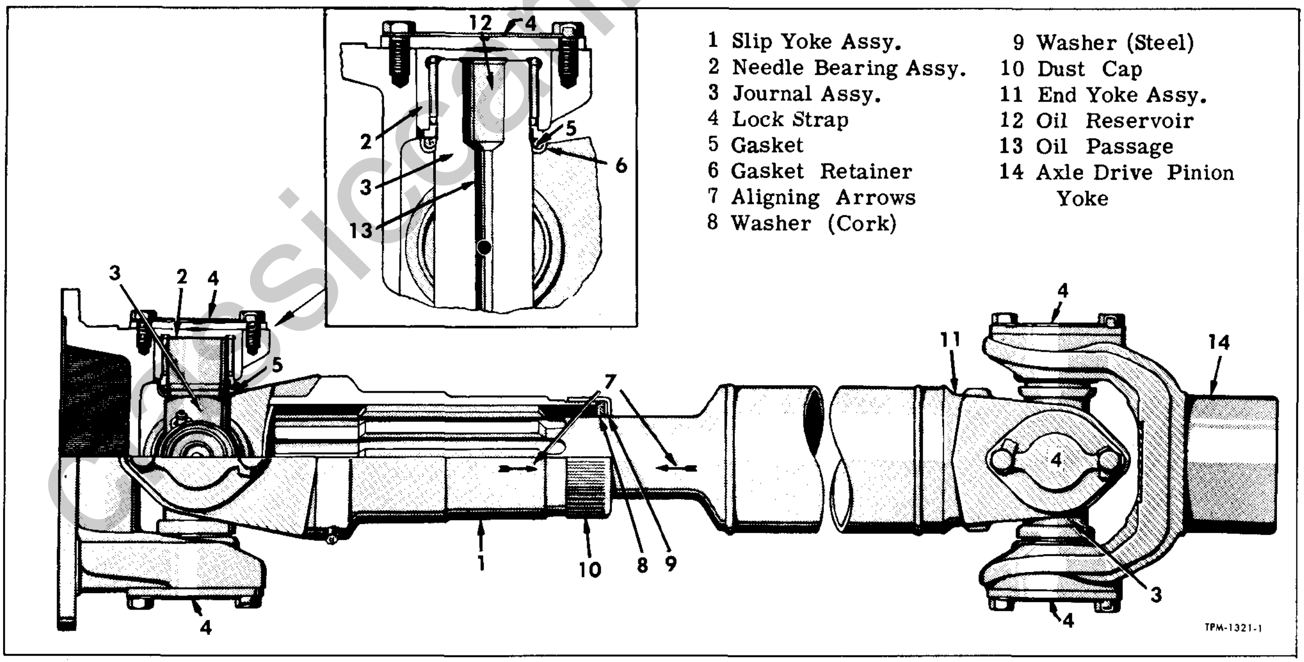


Figure 5—Typical Propeller Shaft with Type 1700 or 1800 Universal Joints

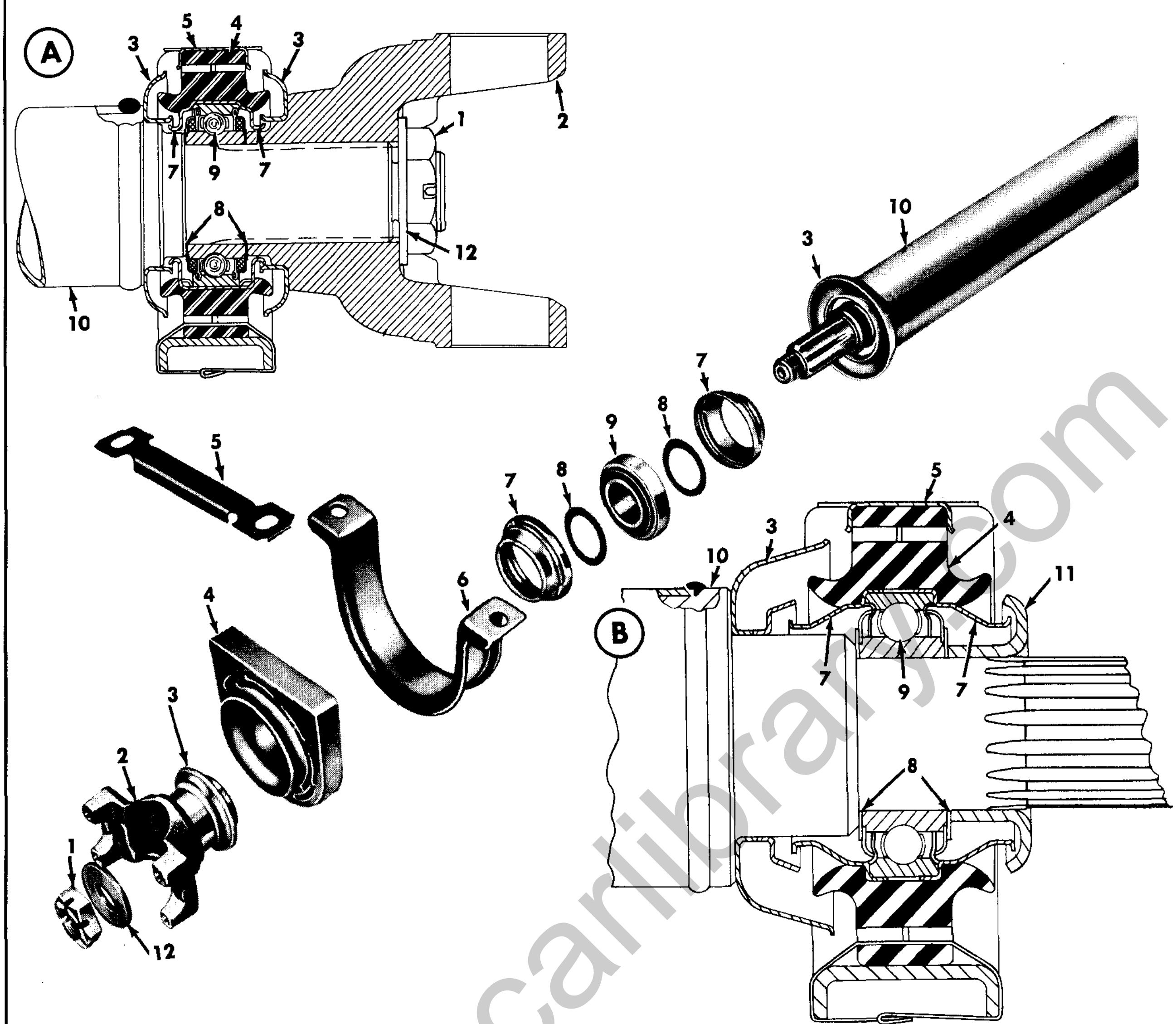


Figure 6—Typical Propeller Shaft Center Bearings

clearance between slip yoke splines and shaft splines. If backlash is excessive, worn parts must be replaced.

CENTER BEARING

Wash all parts except ball bearing and rubber cushion in suitable cleaning fluid.

DO NOT IMMERSE SEALED BEARING IN CLEANING FLUID.

Wipe bearing and cushion clean with a cloth dampened with cleaning fluid.

Check the bearing for wear or rough action by rotating inner race while holding outer race. If wear or roughness is evident, replace with new bearing.

Examine rubber cushion for evidence of hardening, cracking, or deterioration. Replace with new part if damaged in any way.

Grease retainers and slingers are serviced only as a part of the bearing assembly.

ASSEMBLY OPERATIONS

CENTER BEARING ASSEMBLY

Key numbers in text refer to figure 6.

1. If removed, install new dust shields (3) on shaft or yoke. Tack weld or stake shields in place.
2. Press a grease retainer (7) over each side of bearing outer race. Pack cavities in retainers with waterproof grease recommended in LUBRICATION (SEC. 0).
3. Install one slinger (8) over end of shaft. Start bearing and retainer assembly straight on shaft, then using a suitable sleeve to exert force on bearing inner race, press bearing and slinger against shoulder on shaft. Install the other slinger (8) over shaft and position against bearing.
4. Install rubber cushion (4) over bearing making sure bearing is centered in hole in cushion.
5. Position support (6) around cushion and install cushion retainer (5).
6. On type shown in View B, figure 6, press dust shield (11) onto shaft against slinger (8). On type shown in View A, install yoke (2) on shaft.

IMPORTANT: Centerline through yoke flanges must be aligned with centerline of yoke flanges on other end of shaft. Install nut (1), tighten firmly, and secure with cotter pin.

SLIP JOINT ASSEMBLY (Fig. 3 or 4)

1. Position dust cap on shaft, then install steel washer and new cork or felt washer on shaft. Coat shaft splines with lubricant specified in LUBRICATION (SEC. 0).
2. Align arrows on splined shaft and slip yoke and insert shaft into slip yoke. Make certain yokes on both joints are exactly aligned.

IMPORTANT: Journal crosses must be in same plane, or serious vibration will occur, with resultant damage to shaft and components.

3. Thread dust cap onto end of slip yoke. Tighten dust cap by hand only; use of wrench will damage cork or felt washer.
4. Install lubrication fitting in slip yoke.

UNIVERSAL JOINT ASSEMBLY

All Types

Install lubrication fitting in journal. Make sure seals are in place on inner end of bearing cages. Apply lubricant recommended in LUBRICATION (SEC. 0) to needle rollers in each bearing to provide initial lubrication.

Types 58WB and 68WB (Figs. 2 and 3)

NOTE: Low wing bearings (fig. 2) have threaded holes in bearing cage flanges and are used at yoke flanges which do not have threaded holes; high wing bearings do not have threaded holes in bearing cage flanges, and are used at yoke flanges which do have threaded holes.

1. Install bearing assemblies over opposite ends of journals and position against yoke flange. Make sure lug on bearing cage seats in groove in yoke flange. Install cap screws and lock washers and tighten to 70 to 80 foot-pounds torque.
2. Install bearing assemblies on other ends of journal and attach to the other yoke flange in the same manner.

Types 1410 and 1480 (Fig. 4)

1. Install journal in yoke, then install bearing assemblies in yoke over journal trunnions. Use a plastic or rawhide hammer to tap into place.
2. On universal joints using snap rings to retain bearings, press bearings in far enough to clear snap ring grooves, then install snap rings. Hold journal and lightly tap yoke to seat bearings outward against snap rings.
3. On universal joints using U-bolts or self locking bolts, install U-bolts, washers, and nuts or self locking bolts on journal bearing assembly and tighten nuts or bolts to following torque.
   a. 3/8-24 nut, tighten to 35-45 foot-pounds.
   b. 7/16-20 nut, tighten to 70-80 foot-pounds.
   c. 1/2-20 bolt, tighten to 85-105 foot-pounds.

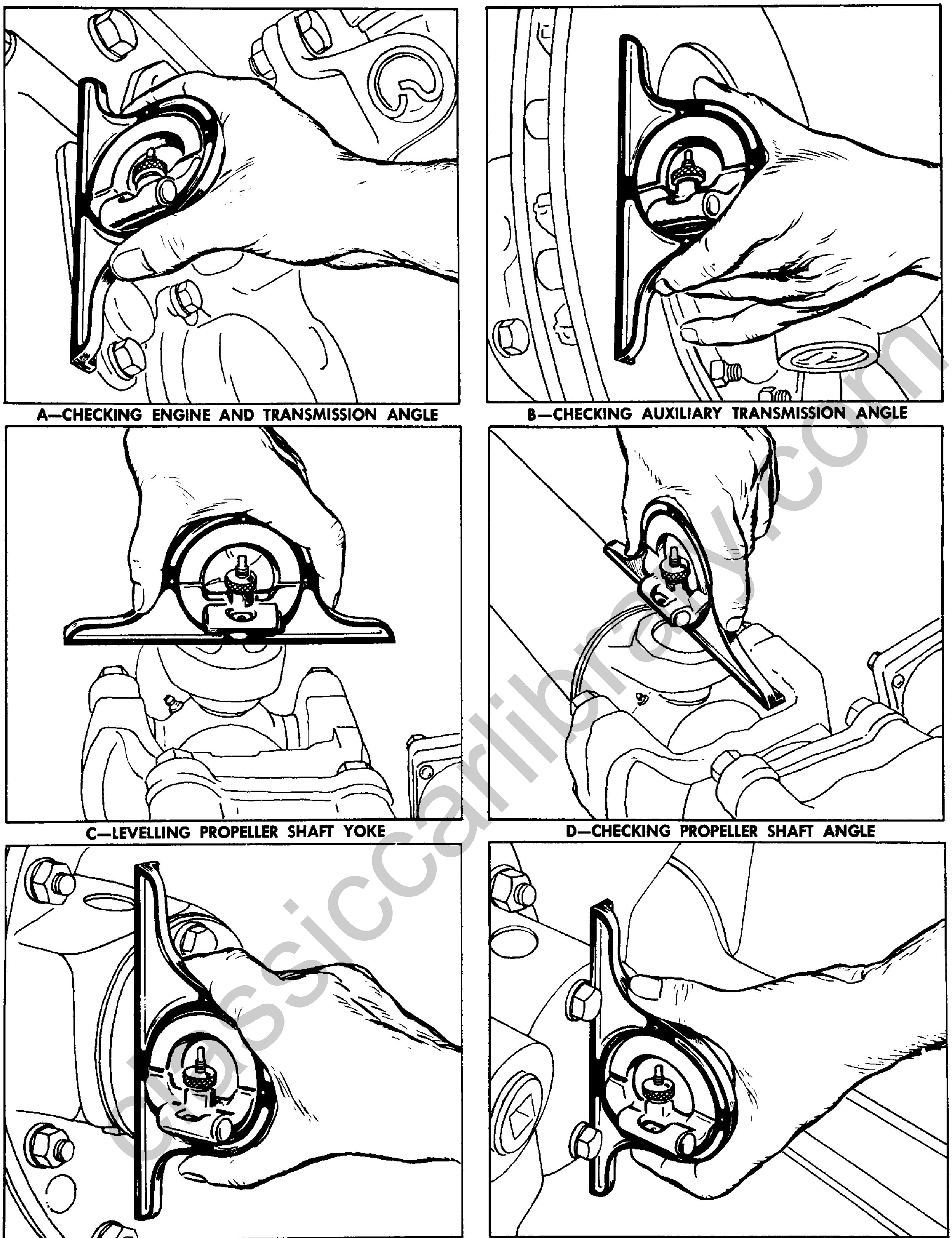
Types 1700 and 1800

1. Lubricate bearing
2. Install journal in yoke, then install bearings (with integral caps) in yoke over journal trunnions. Use a plastic or rawhide hammer to tap bearings into place. Insert cap screws through lock strap and bearing cap and thread into tapped holes in yoke. Tighten cap screws to 30-38 foot-pounds torque, then bend tangs of lock strap up against cap screw head.
3. Insert journal ends into mating yoke and install the other two bearings in the same manner.

PROPELLER SHAFT INSTALLATION

NOTE: All propeller shaft attaching bolts and nuts are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with parts of the same part numbers or with equivalent parts if replacment becomes necessary. Do not use replacement parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

After installing propeller shaft, lubricate all universal joints and slip joints as directed in LUBRICATION (SEC. 0) and torque attaching parts to "Specifications" listed at end of this section.



A—CHECKING ENGINE AND TRANSMISSION ANGLE

B—CHECKING AUXILIARY TRANSMISSION ANGLE

C—LEVELLING PROPELLER SHAFT YOKE

D—CHECKING PROPELLER SHAFT ANGLE

E—CHECKING FORWARD REAR AXLE PINION ANGLE

F—CHECKING REARWARD REAR AXLE PINION ANGLE

TPM-9995

Figure 7—Checking Drive Line Angles

TANDEM AXLE DRIVE LINE ANGLES

Correct drive line angles are necessary to prevent torsional vibration on tandem rear axle models. On some vehicles adjustable auxiliary transmission mountings are provided for adjusting the angle of the various drive line components. On vehicles not having adjustable auxiliary transmission mountings and adjustable torque rods at rear axles, proper adjustment of the angle of the drive line components must be accomplished by the use of spacers or shims at the frame crossmember. The following procedure covers checking and adjusting drive line angles on vehicles equipped with an auxiliary transmission. Without an auxiliary transmission, the same procedures apply, omitting steps applying to the auxiliary transmission.

DRIVE LINE ANGLE ADJUSTMENT

All angles must be checked with a maximum amount of exactness. The use of a devil level or other such instruments is not sufficient; a bevel protractor must be used.

1. The vehicle should be set on a reasonably flat surface. Do not zero the frame.

2. Clean machined surface at rear of main transmission, then use a protractor as shown in View A, figure 7, to check engine and main transmission angle. Protractor must be held straight up and down to get the proper reading. This angle is important, as this is the key angle and the auxiliary and forward rear axle pinion must be set to this angle.

3. Check angle of auxiliary transmission at the Tru-Stop brake disc as shown in View B, figure 7. Surface of disc must be smooth and not warped. The angle of the auxiliary transmission must be the same as the engine and main transmission (step 2). Adjust, if necessary, by raising or lowering front or rear of auxiliary transmission by means of the adjustable mounting bolts on some vehicles, or by removing or adding plates, washers, spacers, etc., on other vehicles (refer to "AUXILIARY TRANSMISSIONS" (SEC. 7C) of this manual for auxiliary transmission mountings).

4. After adjusting auxiliary transmission angle make sure the auxiliary is properly centered in the vehicle as follows: Measure from ends of transmission rear cross beam to the frame (also at front cross beam when used). Measure from auxiliary transmission frame brackets to the ends of the rear cross beam (and front cross beam, when used). Measurements at both ends of each cross beam must be equal. Make adjustments as necessary. If adjustment is made, it is mandatory to recheck the auxiliary transmission angle as described in step 3.

5. Check angle of propeller shaft between main transmission and auxiliary transmission. This shaft angle is important.

a. Clean dirt and paint off machined surface of propeller shaft yoke, and make sure surface is free from nicks or burrs. Set bevel protractor to zero, place protractor on yoke surface as shown in View C, figure 7, then rotate shaft until bubble is centered in glass. Reposition protractor on yoke as shown in View D, figure 7, holding in line with shaft, and note the shaft angle. This shaft angle must be held within a maximum of 1° less than the engine and auxiliary transmission angles, i.e., if engine and transmission angles are 3° 45', shaft angle must be within 2° 45' minimum to 3° 45' maximum.

b. The shaft angle can be adjusted, if necessary, by raising or lowering the auxiliary transmission by taking an equal number of turns at each of the adjustable mounting bolts on some vehicles. On other vehicles it will be necessary to add or subtract plates, washers, spacers, etc., to raise or lower the auxiliary transmission.

NOTE: It is important to make adjustment at each mounting bolt an equal amount so the auxiliary transmission angle will not be changed.

6. On rear axles which have a machined surface on the differential carrier at right angles to the pinion shaft, such as 2-speed shift motor adapter, check angle of the forward rear axle pinion by cleaning the two-speed adapter cover and placing the protractor as shown in View E, figure 7. Make sure protractor is held straight up and down to get a correct angle reading. Pinion angle should be the same as the engine and auxiliary transmission angles. Adjustment can be made, if necessary, by using shims at upper torque rod mountings.

7. On rear axles that do not have a machined surface on the differential carrier housing it will be necessary to remove the interaxle shaft. Rotate the rear pinion yoke on the forward rear axle into a vertical position. Clean the four machined ends of the yoke of dirt, nicks, and burrs. Place the protractor across ends of the yoke on either side in as close as possible to a vertical position as shown in figure 8 and read the angle. Pinion angle should be the same as the engine and auxiliary transmission angles. Adjustment can be made, if necessary, by using shims at upper

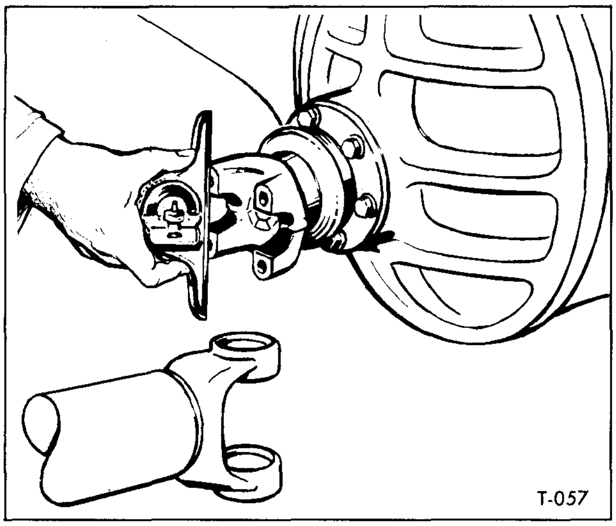


Figure 8—Checking Pinion Angles

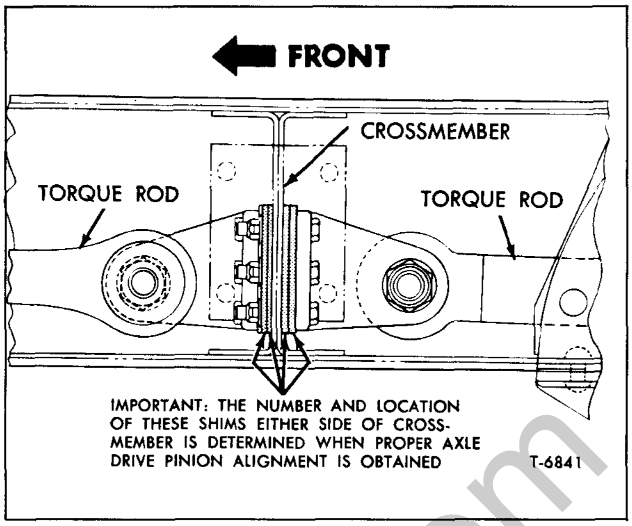


Figure 9—Torque Rods Installed at Frame Crossmember with Shims Installed (Typical)

torque rod mountings.

8. Clean machined surface of yoke on the inter-axle propeller shaft and check the shaft angle in same manner described in Step 5a.

9. Check rearward rear axle pinion angle as described in Step 6 and shown in View F, figure 7, on rear axles which have a machined surface on the differential carrier housing. On rear axles not having a machined surface on the differential carrier housing, check rearward rear axle pinion angle as described in Step 7 and shown in figure 8.

IMPORTANT: The rear axle pinion must be adjusted up or down by shims at torque rod mounting bracket until the resultant angle of the forward axle pinion angle, subtracted from the inter-axle shaft angle, is equal to the resultant angle of the inter-axle shaft angle subtracted from the rear axle pinion angle. Refer to figure 9 for location of shims.

Example: Forward axle pinion angle = 3°.
Inter-axle shaft angle = 6°.
Rear axle pinion angle = 9°.

Forward axle pinion angle (3°) subtracted from inter-axle shaft angle (6°) equals 3°.

Inter-axle shaft angle (6°) subtracted from rear axle pinion angle (9°) equals (3°).

When repairing universal joints do not mix used parts with new. Install new cross and bearing repair kit only.

UNIVERSAL JOINT NUT AND BOLT TORQUE CHART

JOINT SERIES	TORQUE AT TRANSMISSION WITHOUT PARK BRAKE	TORQUE AT TRANSMISSION WITH PARKING BRAKE	BEARING CAP. BOLT	U-JOINT TO AXLE BOLT NUT	CENTER OR INTER. HANGER HANGER BRACKET TO FRAME BOLT NUT	PROPELLER SHAFT SUPPORT TO HANGER BOLT NUT
	FT. LBS.	FT. LBS.	FT. LBS.	FT. LBS.	FT. LBS.	FT. LBS.
1410	50-60	50-60		20-25	15-20	25-30
1480	25-30	60-70		85-105	15-20	25-30
1700	35-45	25-30	33-38	33-38	15-20	40-50
1800	35-45	25-30	33-38	33-38	15-20	40-50
58 WB—68 WB	40-50	60-70		40-50	15-20	25-30

UNIVERSAL JOINT APPLICATION

The following tabulation lists Universal Joints used with Standard Equipment only.
Refer to Parts Book for Universal Joints used with Optional Equipment.

TRUCK SERIES	AT MAIN TRANSMISSION	AT FRONT CENTER BEARING (WHEN USED)	AT REAR CENTER BEARING (WHEN USED)	AT REAR AXLE	INTER-AXLE SHAFT	
					FRONT	REAR
HJ70	58WB	58WB	58WB	58WB		
HM80	1480	1480	1480	1480		
HV70	58WB	58WB	58WB	58WB		
JM80	58WB	58WB	68WB*	68WB*	58WB	58WB
JV70	58WB	58WB	68WB*	68WB*	58WB	58WB
TV70	58WB	58WB	58WB	58WB		
HI90	68WB	68WB	68WB	68WB		
HN90	68WB	68WB	68WB	68WB		
JI90	1700	1700	1700	1700	68WB	68WB
JN90	1700	1700	1700	1700	68WB	68WB
MH90	1700	1700	1700	1700	1700	1700
MI90	1700	1700	1700	1700	1700	1700
FC90	1800	1800	1800	1800		
FH90	1800	1800	1800	1800		
FI90	68WB	68WB	68WB	68WB		
FN90	68WB	68WB	68WB	68WB		
DC90	1800	1800	1800	1800	1700	1700
DH90	1800	1800	1800	1800	1700	1700
DI90	1700	1700	1700	1700	68WB	68WB
DN90	1700	1700	1700	1700	68WB	68WB

*With auxiliary transmission

UNIVERSAL JOINT SPECIFICATIONS

JOINT SERIES	JOURNAL DIAMETER	NO. OF NEEDLES PER BEARING	DIAMETER OF NEEDLES	LENGTH OF NEEDLES	PROPELLER SHAFT FLANGE BOLT OR STUD NUTS	
					SIZE	TORQUE-(FT. LBS.)
1410	0.7730″-0.7735″	34	0.0783″-0.0785″	0.625″	7/16-20	50-60
1480	0.8942″-0.8947″	33	0.0936″-0.0938″	0.78125″	1/2-20	85-105
58 WB	1.0621″-1.0625″	39	0.0928″-0.0930″	0.819″-0.839″	3/8-24	35-45
68 WB	1.0423″-1.0433″	38	0.0936″-0.0938″	0.944″-0.964″	7/16-20-12 POINT SCREW	40-50
1700	1.3201″-1.3206″	36	0.1247″-0.1250″	0.920″-0.925″	7/16-20 U-BOLT	32-37
1800	1.700″-1.696″	45	0.1247″-0.1250″	0.920″-0.925″	3/8-24 U-BOLT	20-24

Proper torque of all mounting flange bolts and universal joint U-bolts should be maintained to prevent vibration and damage to needle bearings and mounting components.

SECTION 5

BRAKES

This group is divided into three sections as shown in Index below:

BRAKE SYSTEM EQUIPMENT

There are two different brake systems used on vehicles covered by this manual.

1. Vacuum Assisted Hydraulic brakes are used on H, J, and T-70 Models when specified on the sales order.

2. Full air brakes are used on these same models when specified on the sales order, plus being used as standard equipment on all other models covered.

3. Optional Equipment is available in both systems. Such items as vacuum reserve tank, heavy duty booster, vacuum gauges, trailer brake connections, air parking brake, moisture ejector, etc., are factory installed options.

HYDRAULIC BRAKES

GENERAL

All models covered by this manual, which use hydraulic brakes, have a vacuum power assisted system. This vacuum assisted system is described as a "one to one" system; that is the volume of hydraulic fluid output of the vacuum booster is the same as the input volume. This type system eliminates the need for compensating lines and also the need for "pumping" the brake pedal in the event of loss of vacuum power assist.

The vacuum system on these vehicles contains a check valve which maintains enough vacuum in the booster chamber to permit at least one power assisted brake application after loss of vacuum occurs.

The various components of the brake system, such as shoe and lining assemblies, pedal and linkage, power boosters, main cylinders, wheel cylinders, lines, gauges, reserve tanks, etc., are covered under respective headings in this section.

For illustration of typical system installation see figure 1.

BRAKE SYSTEM MAINTENANCE

1. Maintain proper level of hydraulic brake fluid in master cylinder. Refer to LUBRICATION (SEC. 0) of this manual for recommended fluid and checking intervals. At least once a year, drain and flush entire brake system and refill with new fluid.

2. Adjust brake shoes at regular intervals. After two or three adjustments, check brake linings for wear. Reline brakes before lining is worn sufficiently to permit rivets to damage brake drums.

3. Keep brake pedal and linkage well lubricated to assure free movement and rapid release of brakes.

4. Inspect entire brake system regularly for fluid leakage. Leakage must be corrected immediately.

5. Make sure brake shoes are free on their mountings, that shoe return springs are not weak or broken, and that backing plates are not sprung or loose on axle or steering knuckle.

6. Service vacuum power cylinder air cleaner, as instructed in this section.

7. Tighten all vacuum and atmosphere line fittings and connections.

8. Perform "Power Brake System Tests" as directed later under "Power Cylinders." These tests may reveal sub-standard performance before the condition becomes bad enough to cause driver complaints or brake failure on the road.

BRAKE ADJUSTMENTS

All brake adjustments to compensate for normal lining wear can be made without removing

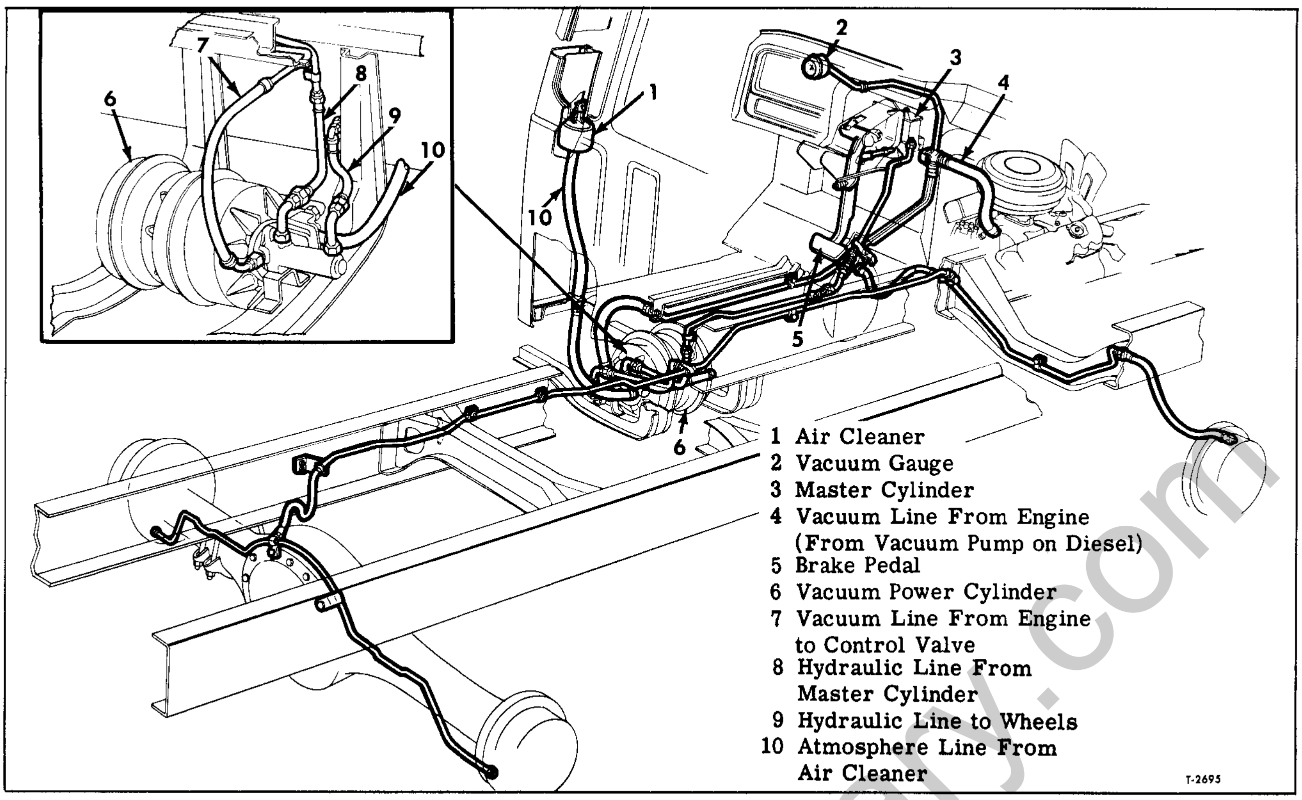


Figure 1—Typical Vacuum and Hydraulic Lines Installed

wheels and brake drums. Adjustment points are accessible through openings in brake backing plate or are external type.

NOTE: Wheel bearings must be properly adjusted before attempting to adjust brake shoes. Refer to "HUBS AND BEARINGS" (SEC. 3D for Front and SEC. 4C for Rear).

Brake shoe adjustment points for front brakes (Type "F") are illustrated in figure 2. Adjustment points for rear brakes (Type "FR-3") are shown in figure 3.

TYPE "F" (Fig. 2)

1. Jack up front end of vehicle until wheels clear floor. Place wrench on one adjusting cam stud to adjust one shoe. Rotate wrench in direction of forward wheel rotation to decrease lining-to-drum clearance. Reduce clearance until brake drag is felt as wheel is turned in forward direction.

2. Move wrench slightly in opposite direction until brake drag is relieved, then move wrench an additional 7 to 10 degrees to provide running clearance. (7 to 10 degrees is equal to 1 to 1½ inches of travel at end of an 8-inch wrench.)

3. Place wrench on opposite adjusting cam stud and adjust second shoe by repeating steps 1 and 2.

TYPE "FR-3" (Fig. 3)

1. Jack up vehicle until wheels are clear of floor. Remove adjusting hole covers from backing plate.

2. At one adjusting slot, insert adjusting tool J-4707 or similar tool through slot and engage adjusting wheel. Move tool toward axle to rotate adjusting wheel and decrease lining clearance until lining drags on drum.

3. Relieve drag by rotating adjusting wheel in opposite direction. Back off adjustment as follows:
   For worn lining - 3 notches (clicks)
   For new lining - 5 notches (clicks)

4. At other adjusting slot, repeat steps 2 and 3 to adjust other shoe.

5. Install hole covers in backing plate.

BLEEDING BRAKES

Use only Hydraulic Brake Fluid recommended in LUBRICATION (SEC. 0) of this manual. When other than recommended fluid has been used, drain and flush the entire hydraulic system, using clean alcohol or a hydraulic brake system cleaning fluid. Disassemble, clean, and inspect hydraulic units. Replace all rubber parts. Refill system with recommended fluid.

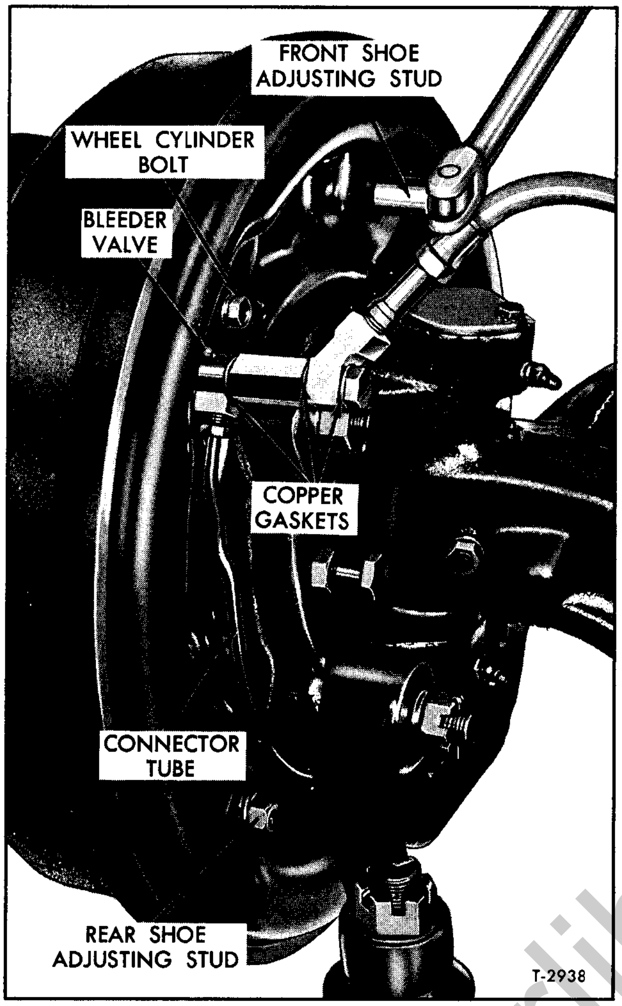


Figure 2—Type "F" Brake Adjustment

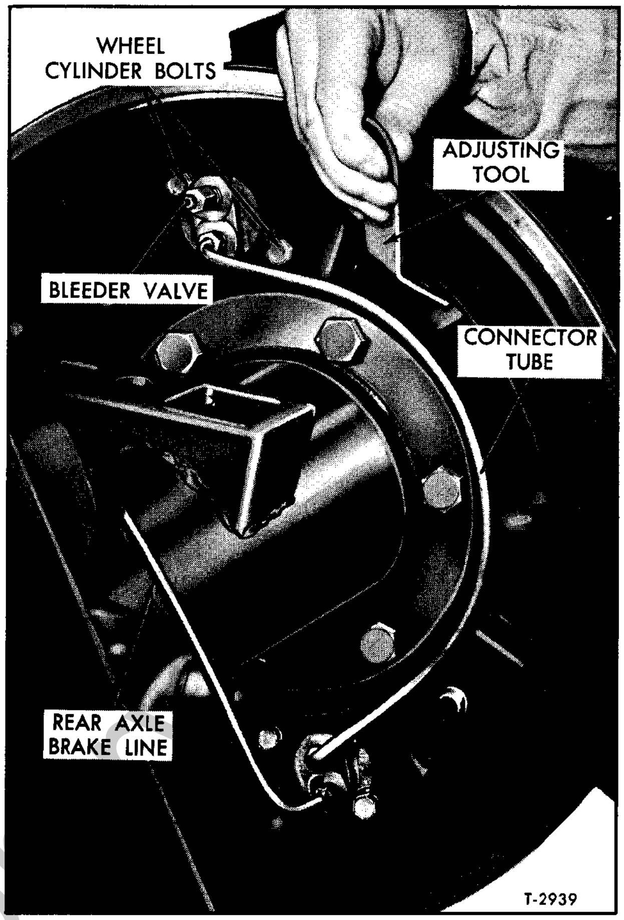


Figure 3—Type "FR-3" Brake Adjustment

The need for bleeding air from system is generally indicated by a springy, spongy pedal action. The presence of air in system is a result of low fluid level in master cylinder, or of some part of the system having been disconnected. Bleeder valves are provided on power cylinder (some models), master cylinder (some models) and at wheel cylinders. Type "F" front brakes on Type "FR-3A" rear brakes have two cylinders per wheel and each has a bleeder valve. Type "FR-3" rear brakes have two cylinders per wheel with a bleeder screw at the top cylinder only. Refer to figures 4 and 5 for bleeding sequence by truck model.

Master cylinder is accessible under the hood on conventional models and through access door in seat riser on tilt cab models. Bleeder valves at wheel cylinders are accessible at inner sides of the backing plates.

It is recommended that brake system be bled in a definite sequence to obtain best results. Figures 4 and 5 illustrate various combinations of brake equipment used, with bleeder valves numbered in the recommended sequence in which they should be bled.

There are two methods of bleeding hydraulic brake systems used on these vehicles; pressure bleeding and manual bleeding. Both are acceptable and adequate but pressure bleeding is recommended, if equipment is available.

CAUTION: Before starting pressure bleeding operations, stop engine and destroy vacuum in system before opening any bleeder valve.

PRESSURE BLEEDING

Refer to figures 4 and 5 for bleeding sequence.

1. Make sure fluid level in pressure tank is up to petcock above outlet and that tank is charged with 40 to 50 psi air pressure.

2. Clean dirt from master cylinder filler cap or cover. Remove standard cover and install special cover required to fit the model cylinder used. Connect pressure tank hose to filler cap or cover opening. Bleed air from hose before tighten-

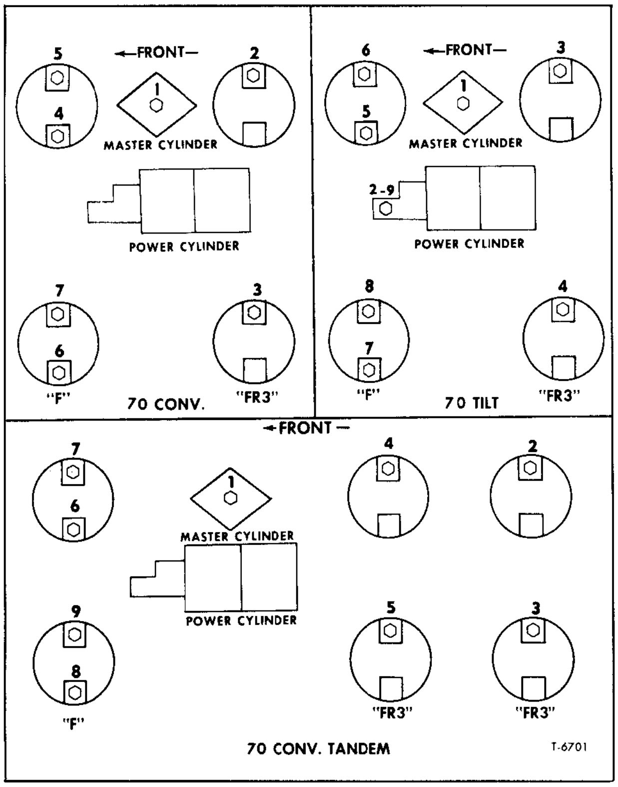


Figure 4—Brake Bleeding Sequence Chart

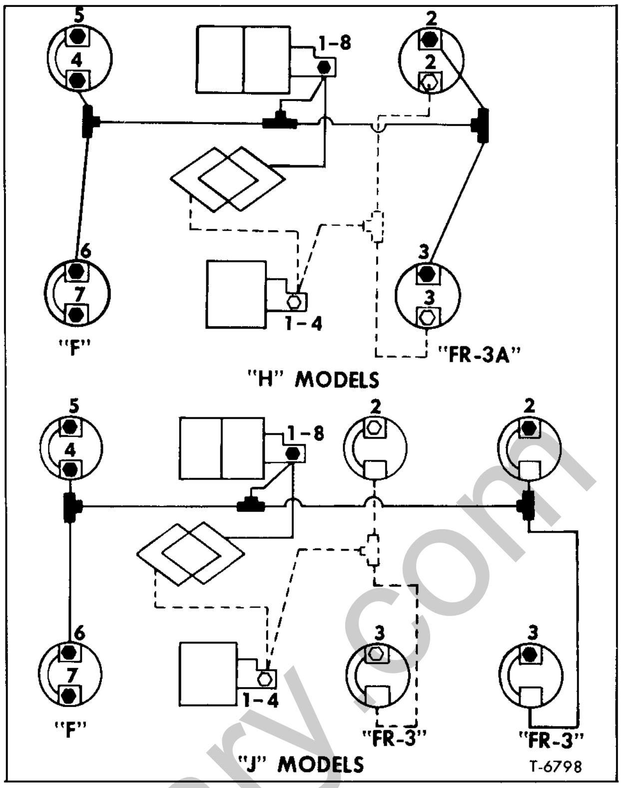


Figure 5—Brake Bleeding Sequence Chart (Split System)

ing connection. Open valves at both ends of hose.

3. First bleed master cylinder valve on models where used. Slip end of bleeder hose over bleeder valve No. 1 and place other end in a glass jar containing enough hydraulic fluid to cover end of hose. Open bleeder valve with wrench and observe flow of fluid from hose. Close bleeder valve as soon as bubbles stop and fluid flows in a solid stream.

4. Bleed valve No. 2 (on power cylinder where used), then bleed wheel cylinders in sequence shown in figures 4 and 5. After bleeding wheel cylinders, repeat bleeding operations at power cylinder (where used).

5. If, after bleeding, the pedal "feel" is not satisfactory, it is recommended that the residual check valve in the master cylinder or the check valve in the power cylinder piston be inspected (on those models which have check valves). Improper operation of either or both of these valves will result in the same pedal "feel" as air in the system. Refer to applicable procedures for repair. If these valves are operating properly, or if "feel" is not satisfactory on models not using check valves, then air is still present in system and bleeding again will be necessary.

MANUAL BLEEDING

Manual bleeding is the same as pressure bleeding, except that the brake fluid is forced through the lines by pumping the brake pedal instead of by air pressure. Fluid in master cylinder must be replenished after bleeding at each valve. Brake pedal should be pumped up and down slowly, and should be on downstroke as valve is closed.

BRAKE PEDAL AND LINKAGE

NOTE: All brake pedal and push rod attachments are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. Each must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

There are two basic types of brake pedal and linkage installations used on vehicles covered by this manual. They are illustrated in figures 5 and 6.

BRAKE PEDAL REPLACEMENT (CONV. CAB MODELS)

These models have a suspended type brake pedal mounted in a bracket which is secured on the underside of the instrument panel.

The brake pedal pivots on the outside of the sleeve, and clutch pedal shaft extends through inside of sleeve. Nylon bushings are installed in each end of brake pedal tube, forming the contact between pedal tube and pedal sleeve. Clutch pedal shaft is carried in nylon bushings installed in each end of sleeve. The master cylinder is mounted on the engine side of the dash. Adjustable push rods, extending through dash into master cylinder bores, are attached to brake pedal lever and to clutch pedal shaft lever by special bolts.

In released position, each pedal is held against a rubber bumper by pedal return springs. The following pedal replacement procedures cover both clutch and brake pedals.

PEDAL REMOVAL (Fig. 6)

In order to remove the brake pedal, the clutch pedal must also be removed.

1. Remove bolts attaching brake and clutch master cylinder push rods to pedal levers.
2. Unhook pedal return springs.
3. Loosen clamp bolt securing clutch pedal shaft lever on end of clutch pedal shaft and remove lever from shaft. Remove spring washer, bushings, and clutch pedal and shaft from sleeve.
4. Remove bolt attaching pedal sleeve to panel-to-dash brace. Remove sleeve from brace, at the same time removing brake pedal and bushings.

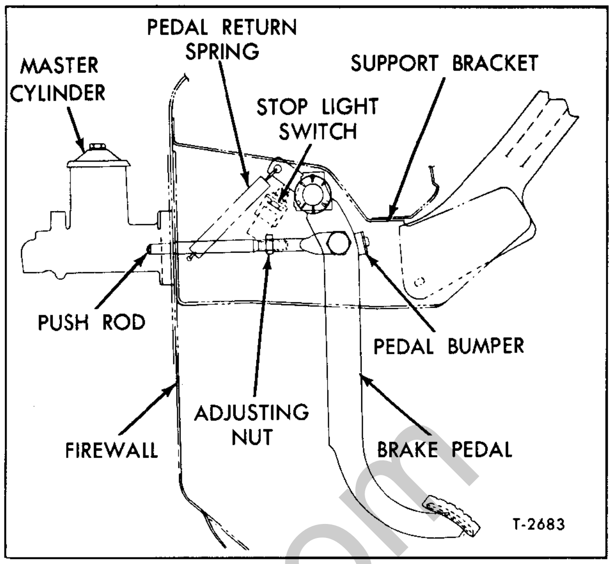


Figure 6—Brake Pedal and Master Cylinder Installation (Conventional Cab Models)

PEDAL INSTALLATION

Before installing pedals, check bushings in brake pedal and in pedal sleeve for evidence of wear or deterioration. Bushings are split type and can easily be removed and replaced.

1. Install bushings in pedal tube. Position

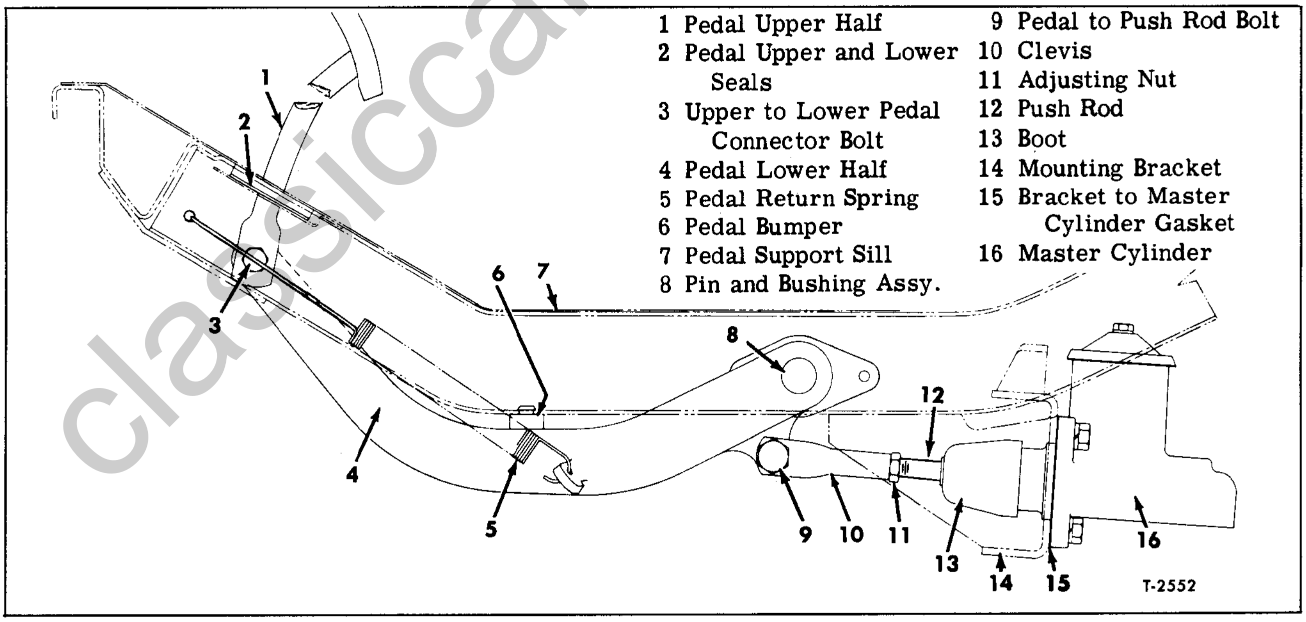


Figure 7—Brake Pedal and Master Cylinder Installation (Tilt Cab Models)

brake pedal at underside of instrument panel-to-dash brace. Insert pedal sleeve through brace and pedal and attach sleeve to brace with bolt and nut.

2. Install bushings in sleeve. Insert clutch pedal shaft through sleeve and install spring washer and pedal shaft lever on end of shaft. Tighten lever clamp bolt firmly.

3. Connect pedal return springs.

4. Connect master cylinder push rods to brake and clutch pedals, using special shoulder bolts, lock washers, and nuts. Tighten nuts to 25-30 foot-pounds torque.

5. Adjust push rod to provide rod to piston clearance as directed below:

PUSH ROD ADJUSTMENT (Fig. 6)

1. Loosen lock nut on brake pedal push rod and shorten push rod until brake pedal is completely clear of brake pedal bumper stop.

2. Place a 0.125-inch shim between brake pedal and brake pedal bumper stop.

3. With master cylinder properly installed on fire wall and master cylinder piston in rearmost position against retaining ring, adjust push rod length until push rod contacts master cylinder piston.

4. Hold push rod firmly and tighten lock nut.

5. Check operation of brakes.

BRAKE PEDAL REPLACEMENT (TILT CAB MODELS)

(Refer to Figure 7)

REMOVAL

In order to remove the brake pedal on tilt cab models, it is necessary to first remove the clutch pedal assembly to obtain enough clearance to remove brake pedal.

1. Remove clutch pedal (for details see "Clutch Pedal and Bushing Replacement" in "CLUTCH CONTROLS" (SEC. 7D) in this manual.

2. Remove upper to lower pedal connector bolt. Remove pedal upper half.

3. Remove pedal return spring.

4. Remove pedal to push rod bolt.

5. Remove lock ring and washer from outside end of pin and bushing assembly.

6. Remove grease fitting from bushing.

7. Remove bolts which fasten bushing assembly to cab sill.

8. Simultaneously slide pedal assembly and bushing assembly out of cab sill in opposite directions, twisting each as necessary to clear sill and other obstructions.

INSTALLATION

1. Simultaneously insert bushing assembly from outer side of cab sill and brake pedal assembly from inner side of cab sill, twisting each as necessary to allow pedal pin to slide completely through bushing and bushing assembly to slide completely through cab sill.

2. Install bolts which fasten bushing assembly to cab sill. Tighten securely.

3. Install grease fitting.

4. Install washer and lock ring on outside end of pin and bushing assembly.

5. Install pedal to push rod bolt.

6. Install pedal return spring.

7. Insert pedal upper half through seals and fasten upper and lower pedal halves with bolt.

8. Install clutch pedal (for details see "Clutch Pedal and Bushing Replacement" in "CLUTCH CONTROLS" (SEC. 7D) of this manual.

PUSH ROD ADJUSTMENT

Before making adjustment, pull the master cylinder boot back on push rod. Visually check to see if the piston is seated firmly against piston snap ring in cylinder bore. If it isn't the push rod is too long and should be shortened.

IMPORTANT: It is better to have push rod adjusted too short than for it to be too long.

To adjust, loosen adjusting nut and grip rod with pliers. Turn in or out of rod end as necessary. Place a .750" shim between pedal bumper and pedal lower half. Adjust so that a slight movement of brake pedal at pad is necessary before end of push rod contacts master cylinder piston.

MASTER CYLINDERS

DESCRIPTION

A double barrel master cylinder is used on TM 80 models. The double barrel cylinder is mounted under cab floor on a bracket with three bolts.

A single barrel, single reservoir master cylinder is used on HM and JM 80 models as standard equipment. The single barrel, single reservoir cylinder is mounted in the engine compartment on the fire wall with two bolts. A single barrel, double reservoir is used on HM and JM 80 models with the optional split brake system. The single barrel, double reservoir cylinder is mounted on engine side of fire wall with four bolts.

Both single and double barrel master cylinders have a bleeder valve in the brake bore. The double reservoir cylinder does not have a bleeder valve.

FILLER CAPS

Filler cap on all cylinders incorporate a combination seal and diaphragm made of rubber. The purpose of this is to prevent dirt from entering the reservoir, to prevent brake fluid leaking out, and to allow for expansion and contraction of fluid level as the result of changes in temperature as well as change in fluid level as the result of normal brake operation. These caps are fastened to the top of the master cylinder by a single bolt down through the center which fits in a threaded hole in the master cylinder body (see figs. 6 and 7).

Brake fluid level in all master cylinders should be checked periodically by removing filler cap and making visual inspection. On conventional models the master cylinder is accessible by lifting the hood to the engine compartment on the left side of vehicle. On tilt cab models the master cylinder is accessible by removing the metal plate on the riser panel below the front of the driver's seat.

MAINTENANCE (ALL TYPES)

Filler caps on all master cylinders are designed to vent the fluid reservoir without permitting loss of fluid. Bypass port between cylinder bore and reservoir and vent hole in filler cap must be kept open to assure proper operation. An obstructed bypass port will prevent return of fluid to reservoir, preventing full release of brakes. Bypass ports may be obstructed as follows:

1. Clogged with dirt -- remove master cylinder and disassemble and clean all parts.
2. Swollen primary cup due to the use of wrong fluid -- overhaul master cylinder, drain and flush entire system; refill with proper fluid.
3. Pedal binding on shaft, preventing full return of piston -- free up and lubricate pedal.
4. Improper push rod adjustment -- adjust push rod.

MASTER CYLINDER REPLACEMENT

NOTE: All master cylinder to fire wall fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. Each must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

CONVENTIONAL MODELS

Removal

1. Place a suitable container under master cylinder to catch fluid when hydraulic line is disconnected. DO NOT RE-USE THIS FLUID.
2. Disconnect hydraulic line from outlet.
3. Pull push rod boot off master cylinder tube which extends through dash. Boot will remain on push rod when master cylinder is removed.
4. Remove two bolts (four on double reservoir) and lock washers attaching master cylinder to dash (nuts are welded to inner side of dash) and remove master cylinder assembly.

<u>Installation</u>

1. Place gasket over cylinder tube. Position master cylinder assembly at dash, while an assistant inside cab guides push rod into piston. Attach cylinder to dash with two bolts (four on double reservoir) and lock washers. Tighten bolts firmly.
2. Connect hydraulic line to brake cylinder outlet.
3. Inside cab, place push rod boot over end of cylinder tube.
4. Adjust push rod as previously directed under "Brake Pedal and Linkage."
5. Fill master cylinder reservoir and bleed brake system as previously directed under "Bleeding Brakes."

TILT CAB MODELS

<u>Removal</u>

1. Tilt cab forward and place a suitable container under master cylinder to catch fluid when hydraulic lines are disconnected.

   NOTE: DO NOT RE-USE THIS FLUID.
2. Disconnect hydraulic lines from outlets.
3. Pull push rod boots off master cylinder. Boots will remain on push rods when master cylinder is removed.
4. Remove three bolts attaching master cylinder to support bracket and remove master cylinder assembly.

<u>Installation</u>

1. Position master cylinder assembly at support bracket and guide push rods into pistons. Attach cylinder with three bolts. Tighten bolts firmly.
2. Connect hydraulic lines to brake and clutch cylinder outlets.
3. Place push rod boots over ends of master cylinder brackets.
4. Adjust push rods as directed under "Brake Pedal and Linkage."
5. Fill master cylinder reservoir and bleed brake system as directed under "Bleeding Brakes."

MASTER CYLINDER OVERHAUL

SINGLE RESERVOIR

The following procedures cover disassembly, cleaning, inspection and repair, and assembly of

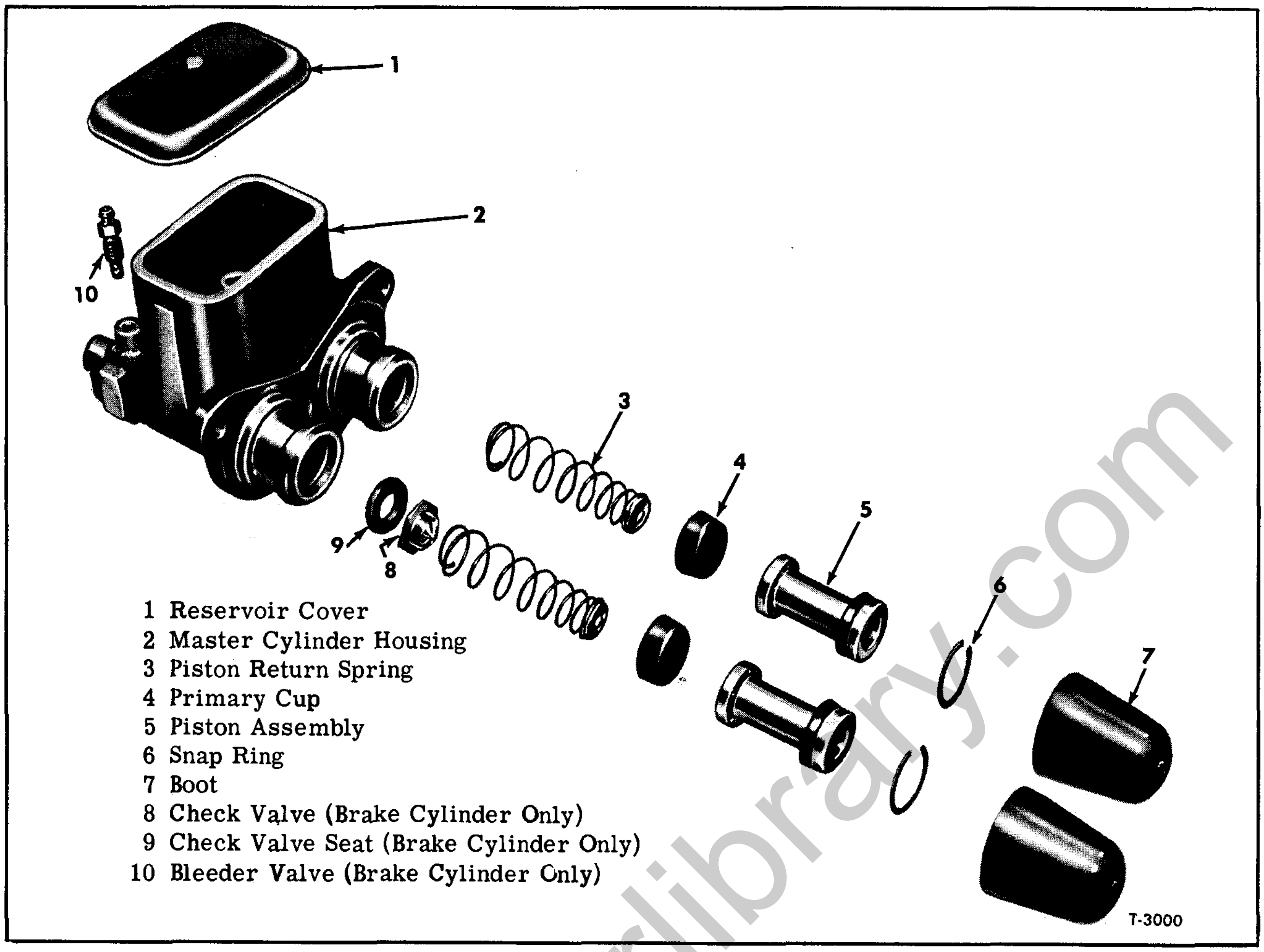


Figure 8—Double Barrel Master Cylinder Components

components used in both the brake and clutch cylinder bores on double barrel master cylinders and on brake cylinder bores on single barrel cylinders.

Disassembly (Fig. 8)

1. Clean all dirt from outside of unit, using a non-petroleum solvent.
2. Remove snap ring from groove in both cylinder bores.
3. Remove piston assembly, primary cup, return spring and retainer assembly, check valve and check valve seat from brake cylinder bore (where used).
4. Remove piston assembly, primary cup, and return spring and retainer assembly from clutch cylinder bore.
5. Remove cover from cylinder housing.
6. Remove bleeder screw (where used).

Cleaning

Immerse all parts in denatured alcohol and wash thoroughly. Wipe small parts dry and blow out inside of reservoir and cylinder bores. Make sure intake and bypass ports in cylinder housing and bleeder holes in piston are clean.

CAUTION: DO NOT use kerosene or gasoline for cleaning master cylinder components.

Inspection and Repair

Master cylinder repair kits are available which contain all the parts ordinarily required when overhauling master cylinders. Refer to applicable Parts Book for part number of repair kit. In addition to replacement of parts contained in repair kit, master cylinder should be inspected and repaired, if necessary, as follows:

1. Examine cylinder bores. If scored or rusted, recondition by honing. Be sure to use proper size hone. (Refer to "Specifications" for nominal diameter of cylinder bores.) Do not hone more than necessary to remove scores and smooth up cylinder. Remove burrs caused by honing from around by-pass and intake ports.

2. Check the piston fit in the cylinder bore. Clearance between the piston and cylinder wall should be within 0.001" to 0.005" when checked with feeler gauge.

Assembly (Fig. 8)

1. Before assembling, coat inside of cylinder bores and dip all internal parts in hydraulic brake fluid.

2. Install components in brake cylinder bore of both single and double barrel cylinders as follows:

a. Install check valve seat in cylinder bore, then position check valve on seat (where used).

b. Install return spring (shortest of the two) in bore with large diameter end of spring over check valve.

c. Install primary cup in cylinder bore with lip of cup toward outlet end. Make sure end of return spring seats inside the cup.

d. Insert piston and secondary cup assembly into cylinder bore, with open end of piston toward open end of cylinder.

e. Press piston into cylinder bore, compressing spring, and install snap ring in groove in bore. Make sure snap ring is fully seated in groove.

3. Install components in clutch cylinder bore as follows:

a. Install return spring (longest of the two) in cylinder bore, large diameter end first.

b. Install primary cup in cylinder bore with lip of cup toward outlet end. Make sure end of spring seats inside the cup.

c. Insert piston and secondary cup into cylinder bore, with open end of piston toward open end of cylinder.

d. Press piston into cylinder bore, compressing spring, and install snap ring in groove in bore. Make sure snap ring is fully seated in groove.

4. Install cover on cylinder reservoir.

DOUBLE RESERVOIR

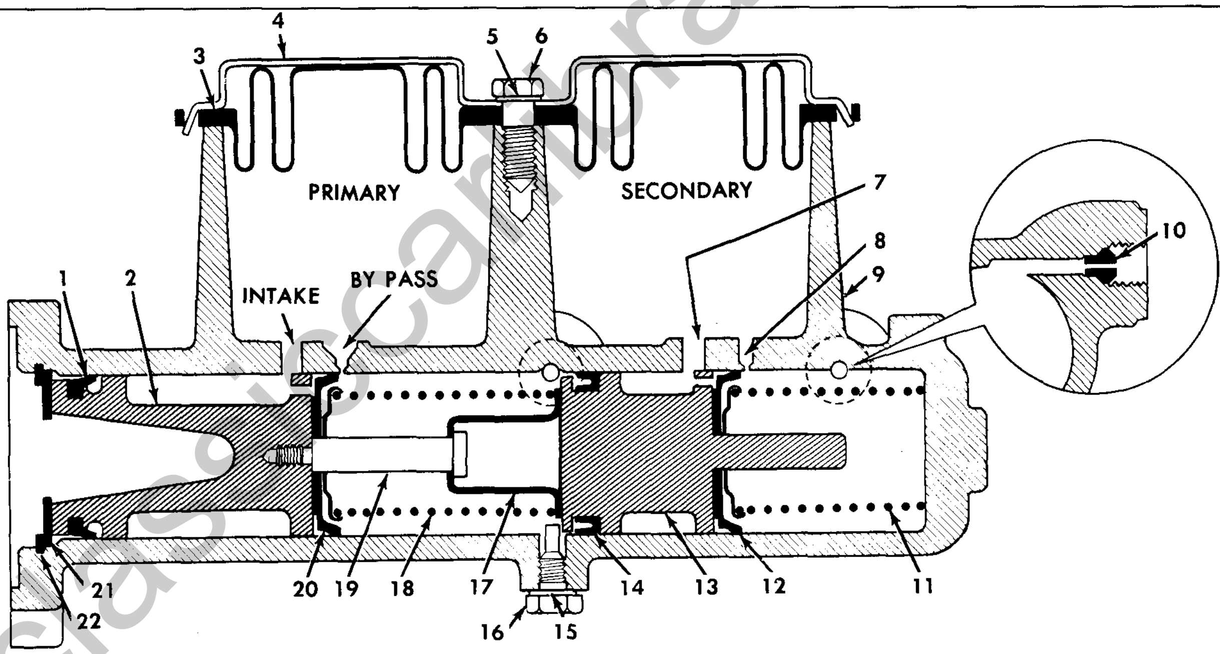
Disassembly (Refer to Fig. 9)

1. Remove cylinder cover bolt and gasket.

2. Lift off reservoir cover and cover seal. Pour out any excess fluid and stroke piston to force fluid through outlet ports.

3. Remove piston stop bolt and gasket from bottom of reservoir housing.

4. Use snap ring pliers and remove retainer ring from groove in end of cylinder bore.



1 Primary Piston Seal Cup
2 Primary Piston
3 Cover Seal
4 Reservoir Cover
5 Gasket
6 Cover Bolt
7 Intake Port
8 By-Pass Port
9 Reservoir Housing
10 Tube Seat
11 Secondary Piston Return Spring
12 Secondary Piston Pressure Cup
13 Floating Secondary Piston
14 Secondary Piston Seal Cup
15 Gasket
16 Stop Bolt
17 Primary Return Spring Retainer
18 Primary Return Spring
19 Primary Piston Stop Pin
20 Primarv Piston Pressure Cup
21 Stop Plate
22 Retainer Ring

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Figure 9—Split System Master Cylinder

5. Remove stop plate.

6. All internal parts should slide easily out of cylinder bore. If they do not, apply compressed air carefully at front outlet port. If parts do not remove easily, examine bore carefully for extensive damage which may eliminate the possibility of reconditioning the master cylinder.

Cleaning and Inspection

Clean all parts in denatured alcohol or brake fluid. If reservoir housing is degreased, finish clean to remove all trace of other solvents. Inspect cylinder bore for scratches or corrosion. Minor blemishes can be removed with crocus cloth or a clean-up hone. DO NOT OVERSIZE CYLINDER MORE THAN 0.007-INCH OVER NOMINAL INSIDE DIAMETER.

Check by-pass ports in both reservoirs to make sure they are open and free of burrs. Probe parts with soft copper wire 0.020-inch in diameter, or smaller. Do not use steel wire to check parts. This may scratch bore of master cylinder or cause burrs in port.

Remove and discard all rubber parts. All rubber parts are included in repair kit which is available from regular service parts sources.

Assembly (Refer to Fig. 9)

1. Coat all parts with a liberal amount of brake fluid.

2. Install rubber seal cup on secondary piston with cup lip facing rear (open end of cylinder).

NOTE: All other cup lips face opposite direction (closed end of cylinder).

3. Stack and install secondary piston spring, pressure cup and piston in cylinder bore.

4. Install piston stop bolt and gasket, making sure screw enters cylinder bore behind rear of piston.

5. Assemble and install primary piston parts in cylinder bore.

6. Install stop plate in cylinder bore.

7. Compress all parts in cylinder bore and install retainer ring in groove.

8. Install reservoir cover and seal.

BRAKE PIPE DISTRIBUTION AND SWITCH ASSEMBLY

All models with split brake system are equipped with a brake pipe distribution and switch assembly. The hydraulic brake lines are routed from the master cylinder, through the switch assembly, to the front and rear brakes. The switch is wired electrically to the brake alarm indicator light on the instrument panel. In the event of fluid loss in either the main or secondary brake system, the indicator light will come on when the brakes are applied. If this light comes on during vehicle operation, it is an indication that there is a failure somewhere in the brake system. The truck should be removed from service as soon as possible and the trouble corrected.

This light also comes on when the ignition key is held in the "START" position. As soon as the key is released to the "ON" position, the light goes out. The purpose of this is to assure the driver that the warning light is not burned out.

BRAKE PIPE DISTRIBUTION AND SWITCH ASSEMBLY REPLACEMENT

REMOVAL

1. Disconnect battery cable.

2. Disconnect electrical lead from pressure differential switch.

3. Place dry rags below the switch to absorb any fluid spilled during removal of switch.

4. Disconnect four hydraulic lines from connections at switch. If necessary, loosen line connections at main cylinder. Cover open line ends with clean, lint-free material to prevent foreign matter from entering the system.

5. Remove mounting screw and remove switch from vehicle.

INSTALLATION

1. Make sure new switch is clean and free of dust and lint. If any doubt exists, wash switch in suitable solvent, and dry with air.

2. Place switch in position and secure to bracket with mounting screw.

3. Remove protective material from open hydraulic brake lines and connect lines to switch. If necessary, tighten brake line connections at main cylinder.

4. Connect switch electrical lead.

5. Connect battery cable.

6. Bleed the brake systems as outlined in this manual.

TESTING DISTRIBUTION AND SWITCH ASSEMBLY

1. Determine if bulb is functioning by turning key in ignition switch to "START" position.

2. Check main cylinder to make sure both reservoirs have enough fluid. Add if necessary.

3. Turn key in ignition switch to "ON" position.

4. Open wheel cylinder bleed screw at one rear wheel.

5. Depress brake pedal and hold down. The brake warning light should come on due to pressure difference between front and rear systems. Approximately 200-250 psi differential is needed to operate brake light switch.

6. Close bleed screw, then release brake pedal. Refill rear reservoir, if needed.

NOTE: Caution should be taken to prevent air from entering hydraulic system during checks on switch.

7. The recommended interval for checking switch is 24 months, or 24,000 miles, any time major brake work is done, or any time brake operation is abnormal.

WHEEL CYLINDERS

All models covered by this manual have type "F" front brakes and type "FR-3" or "FR-3A" rear brakes. Except for size of cylinder bore and diameter of internal parts all front wheel cylinders are the same and all rear wheel cylinders are the same. See figure 10 for cross-section illustration of both.

Since wheel cylinders can be disassembled and repaired without removing them from the vehicle the procedures are covered in this manual along with "Replacement" procedures.

WHEEL CYLINDER REPLACEMENT

TYPE "F"

Removal

1. Block wheels, jack up axle and remove brake shoes as directed under "Brake Shoe Removal."
2. Disconnect axle brake tube from inlet connector at upper cylinder. Remove inlet connector attaching connecting tube fitting to upper cylinder, and remove bolt attaching connecting tube fitting to lower cylinder. Remove connecting tube and fitting assembly.
3. Remove one large and two small bolts attaching each cylinder to backing plate, then remove cylinders from backing plate.

Installation

NOTE: The two wheel cylinders mounted on each brake are identical; however, cylinders on right- and left-hand brakes have opposite cylinder castings. Clean mating surfaces of cylinders and backing plate to insure proper alignment.

1. Place each cylinder on backing plate and attach with one large and two small bolts and lock washers.
2. Position wheel cylinder connecting tube and fittings assembly and attach fitting to lower opening in upper cylinder with inlet connector, using new copper gasket on both sides of fitting. Attach fitting to lower opening in lower cylinder with special bolt, using new copper gasket on both sides of fitting. Tighten inlet connector and special bolt firmly.
3. Install bleeder valve in upper opening in each cylinder.
4. Install brake shoes as directed under "Brake Shoe Installation." Bleed brake system as directed under "Bleeding Brakes."

TYPE "FR-3" AND "FR-3A"

Removal

1. Block wheels, jack up axle and remove brake shoes as directed under "Brake Shoe Removal."
2. Disconnect axle brake tube from upper cylinder at inner side of backing plate. Remove wheel cylinder connecting tube at inner side of backing plate.
3. Remove two bolts and lock washers attaching each wheel cylinder to backing plate. Remove

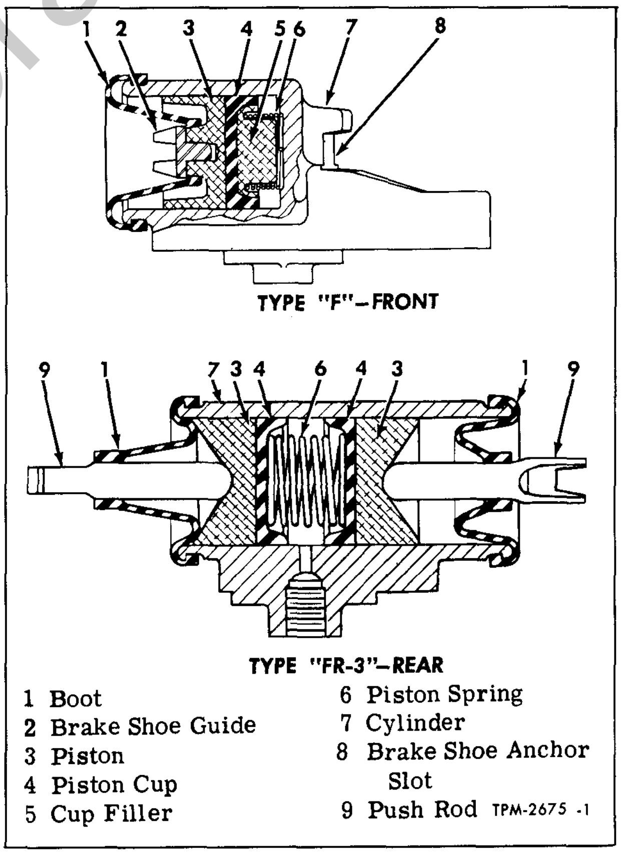


Figure 10—Wheel Cylinders

wheel cylinders and heat shields, then remove heat shields from cylinders.

Installation

NOTE: Upper and lower wheel cylinders on both right- and left-hand brakes are interchangeable. Cylinders must be positioned on backing plate so that the long stroke end of the cylinder faces the shoe toe (adjustment end of shoe) or the adjusting slot in backing plate. Make sure mating surfaces of cylinders, heat shields, and backing plate are clean to assure proper alignment.

1. Position heat shield on each wheel cylinder and install on backing plate, and attach each cylinder with two bolts and lock washers.
2. Attach connecting tube to upper opening in lower cylinder and to lower opening in upper cylinder. Connect axle brake tube to lower opening in lower cylinder, and install bleeder valve in upper opening in upper cylinder (fig. 3). NOTE: "FR-3A" brakes have bleeder valve in each cylinder.
3. Install brake shoes as directed under "Brake Shoe Installation." Bleed brake system as directed under "Bleeding Brakes."

WHEEL CYLINDER REPAIR

TYPE "F"

Disassembly

Pull boot off end of cylinder, then remove boot and piston. Pull boot off piston. Brake shoe guide is pressed into piston and cannot be removed. Remove piston cup, cup filler, and spring from cylinder. Remove bleeder valve from cylinder.

Inspection and Repair

1. Repair kits are available which contain the parts to be replaced when overhauling wheel cylinders. Refer to Parts Book for repair kit part numbers.
2. Inspect cylinder bore for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, replace cylinder.
3. Check fit of new pistons in cylinder bore, using a feeler gauge (see fig. 11). Clearance should be within 0.0025" to 0.0065" on "F" type cylinders. Replace cylinder if clearance exceeds maximum.

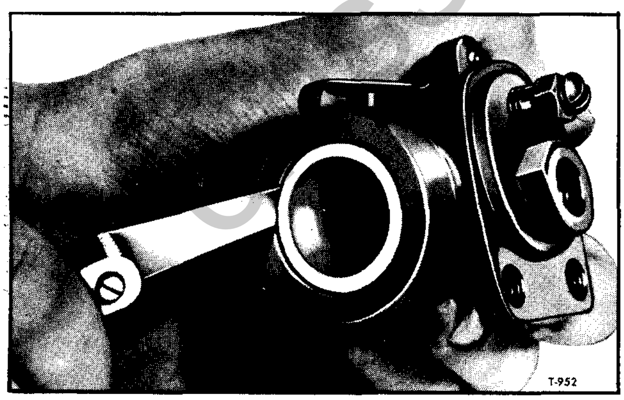


Figure 11—Checking Fit of Piston in Wheel Cylinder

Assembly

Before assembling wheel cylinder, be sure each part has been cleaned in denatured alcohol.

CAUTION: DO NOT use kerosene or gasoline for cleaning wheel cylinder parts. Dip each internal part in hydraulic brake fluid before assembling.

1. Insert piston spring, cup filler, and cup into cylinder bore. Cup filler bumper and cup lip must face closed end of cylinder.
2. Assemble boot on piston, making sure the boot snaps over the brake shoe guide.
3. Install piston and boot, inserting piston into cylinder and engaging boot lip in groove in edge of cylinder. Position brake shoe guide so slot in guide is parallel with flat mounting surface of cylinder.

TYPE "FR-3"

Disassembly

Pull boots off ends of cylinders and remove push rods from boots. Push pistons, cups, and spring out of cylinder. Remove bleeder valve from upper cylinder.

Inspection and Repair

1. Repair kits are available which contain the parts to be replaced when overhauling wheel cylinders.

IMPORTANT: Only genuine Chevrolet parts should be used. Non-genuine parts may deteriorate and swell in a short time, resulting in faulty brake operation.

2. Inspect cylinder bore for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, replace cylinder.
3. Check fit of new pistons in cylinder bore, using a feeler gauge as shown in figure 11. Clearance should be within 0.001" to 0.005" on "FR-3" type. Replace cylinder if clearance exceeds the maximum.

Assembly

Before assembling wheel cylinder, be sure each part has been cleaned in denatured alcohol.

CAUTION: DO NOT use kerosene or gasoline for cleaning wheel cylinder parts. Dip each internal part in hydraulic brake fluid before assembling.

1. Install pistons, piston cups, and spring, with cup lips toward inside of cylinder.
2. Assemble push rods and boots, then install on cylinder. Seat boots evenly in cylinder grooves. Align push rod slots as shown in figure 10.
3. Install bleeder valve in upper cylinder.

HYDRAULIC BRAKE LINES

Hydraulic brake system units are interconnected by flexible hose and special metal tubing. Flexible hose is used between master cylinder (on cab) and frame connection, between frame and front wheel cylinders, and between frame and rear axle brake line. Whenever hydraulic lines have been disconnected for any reason, brake system must be bled, after connecting lines, as directed under "Bleeding Brakes."

FLEXIBLE HOSE

At front wheels, hose fitting is threaded into wheel cylinder connector, with a copper gasket used between shoulder on hose fitting and connector. Fitting at other end of hose is inserted through hole in frame and secured by a toothed lock washer and nut or by a spring lock. Brake tube connector or tee fitting threads into end of hose fitting.

At rear axle, fitting at one end of hose is threaded into axle tee, with a copper gasket used to seal the connection. Other end of hose is inserted through frame bracket and secured by a toothed lock washer and nut or by a spring lock. Brake tube connector or tee fitting threads into end of hose fitting.

To remove hose, disconnect end at frame or frame bracket, then unscrew hose fitting from wheel cylinder or rear axle tee. When installing hose, always use a new copper gasket at wheel cylinder and rear axle tee. When frame end of hose is secured by a nut, always hold hose fitting with a wrench while tightening nut to prevent twisting hose.

METAL TUBING

When necessary to replace metal brake tubing, always use special metal tubing which is designed to withstand high pressure and to resist corrosion. Ordinary copper tubing is not satisfactory for use as hydraulic brake lines. When replacing tubing, always use the same size as that removed.

TUBE FLARING

In order to insure a proper flare, a special flaring tool must be used. When using tool, instructions furnished by the tool manufacturer should be followed. Always inspect newly formed flares for cracks or malformations which might cause leaks.

VACUUM POWER CYLINDERS

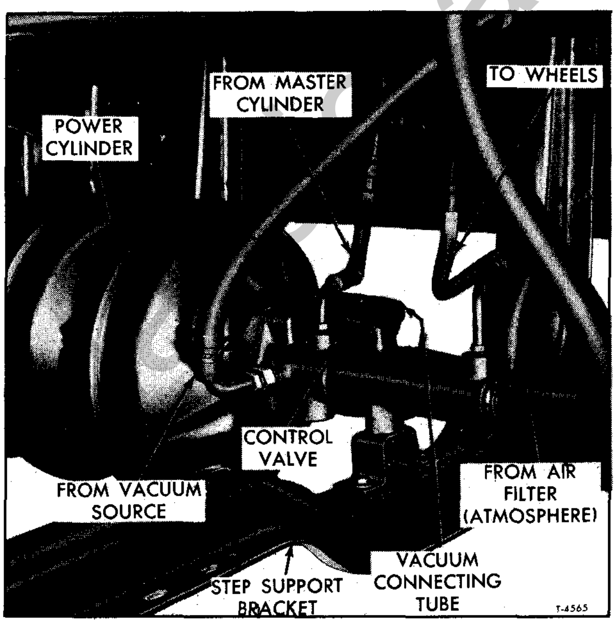


Figure 12—Power Cylinder Installed (Conv. Cab Models)

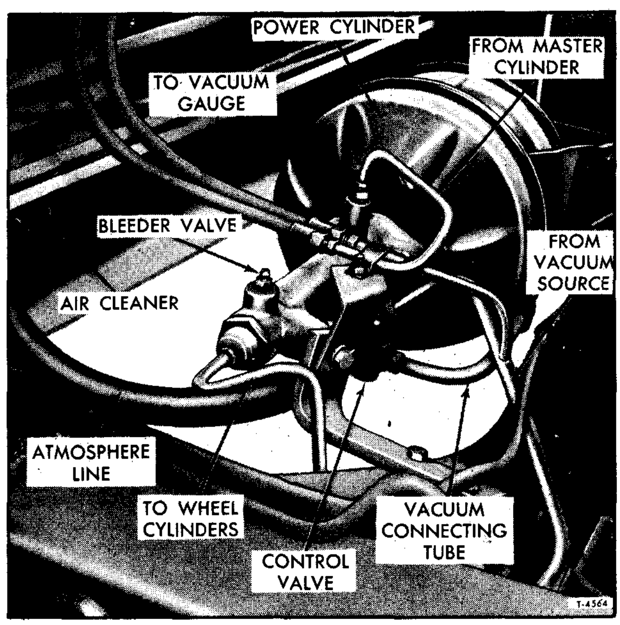


Figure 13—Power Cylinder Installed (Tilt Cab Models)

All models covered by this manual which have hydraulic brakes have tandem diaphragm vacuum power cylinders as standard equipment.

The power cylinder is a combined vacuum - hydraulic power unit, utilizing vacuum and atmospheric pressure for its operation.

The vacuum source on these models is the engine intake manifold.

The combination of vacuum in front of the diaphragm and atmospheric pressure behind the diaphragm results in the power application of the brakes.

VACUUM POWER BRAKE SYSTEM TESTS

VACUUM TEST

With engine stopped, hand brake applied and transmission in neutral, apply brakes several times to destroy all vacuum in system.

Depress brake pedal, and while holding foot pressure on pedal, start engine. (It may be necessary to pump pedal two or three times to build up pedal reserve.) If vacuum system is operating, pedal will tend to fall away under foot pressure when engine starts, and less pressure will be required to hold pedal in applied position. If no action is felt, vacuum system is not functioning.

Inspect vacuum lines for leakage, and for restriction caused by bent or kinked tube or hose. If no fault is found in lines, trouble is in power cylinder control valve, necessitating overhaul of power cylinder.

HYDRAULIC TEST

Stop engine and again destroy all vacuum in system. Depress brake pedal and hold foot pressure on pedal. (It may be necessary to pump pedal two or three times to build up pedal reserve.) If brake pedal gradually falls away under foot pressure hydraulic system is leaking, either internally or externally.

Inspect all hydraulic line connections for leakage and make the necessary repairs. If no external leaks are evident, inspect master cylinder and wheel cylinders and replace parts as necessary. If the condition still exists, an internal leak in power cylinder is indicated, necessitating overhaul of power cylinder.

POWER CYLINDER REPLACEMENT

The installed location of vacuum power cylinders varies by model (see figs. 12 and 13).

Conventional - Behind cab step, immediately below left-hand door. Vacuum reserve tank is located in this same area, when used.

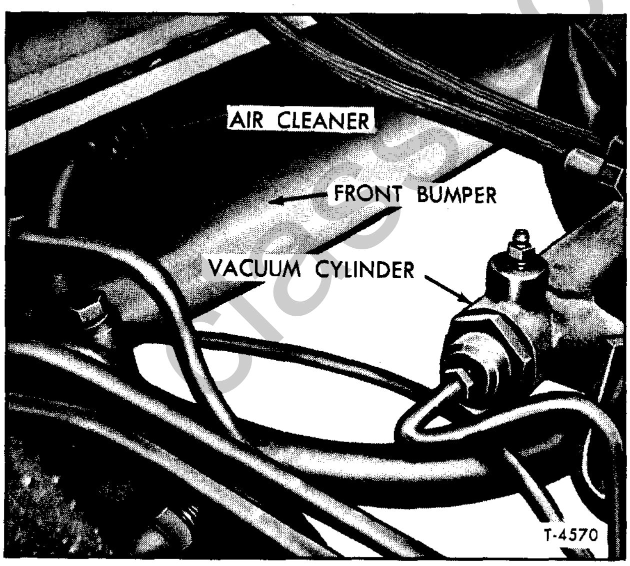


Figure 14—Power Cylinder Air Cleaner Installed (Tilt Cab)

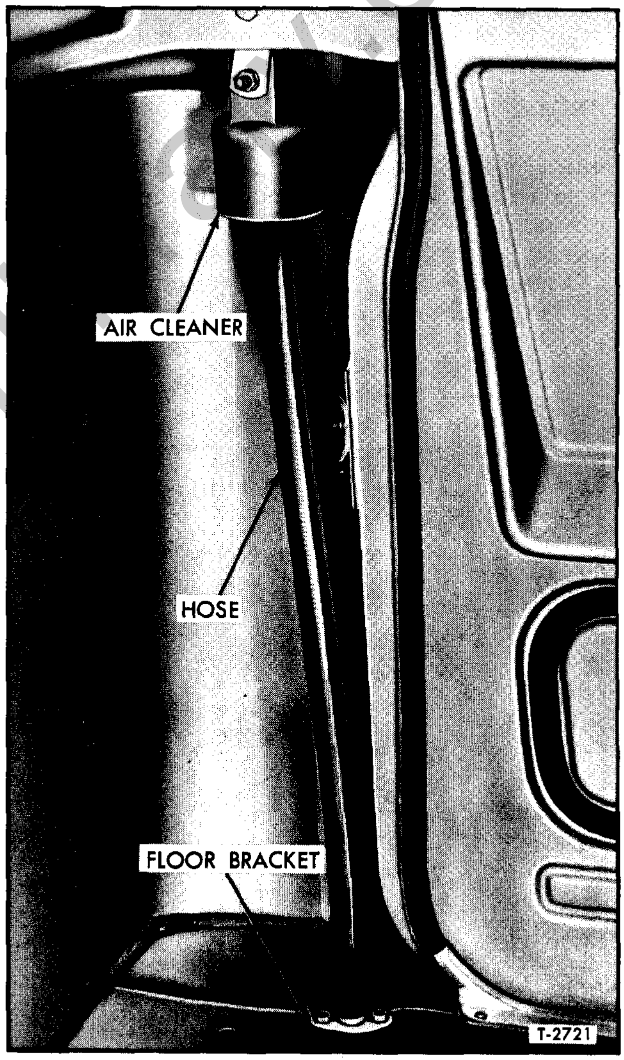


Figure 15—Power Cylinder Air Cleaner Installed (Conv. Cab)

Tilt Cab - Between frame side rails in front of the radiator and behind the front bumper.

REMOVAL

1. For easier accessibility, it is recommended that cab step be removed on conventional models and that cab be tilted forward on tilt cab models.

2. Clean away as much road dirt grease as possible to prevent contamination of vacuum or hydraulic systems.

3. Have suitable container available to catch hydraulic brake fluid which will flow from system. DO NOT RE-USE THIS FLUID.

4. Disconnect all hydraulic, vacuum and atmospheric lines and hoses from power cylinder.

5. Remove bolts and nuts which fasten cylinder to vehicle frame and support brackets. Remove power cylinder.

INSTALLATION

1. Place power cylinder in position and fasten with nuts and bolts to vehicle frame and support brackets.

2. Connect all hydraulic, vacuum, and atmospheric lines and hoses to power cylinder.

3. Bleed master cylinder and vacuum power cylinder as directed under "Bleeding Brakes" in this manual. If ONLY the power cylinder has been removed, it should not be necessary to bleed the wheel cylinders IF the master cylinder and power cylinders are bled first AND lines to wheel cylinder have not been disturbed.

4. Start engine and test operation of brake system as directed. Refer to "Troubleshooting Chart" in this section if operation is not satisfactory.

VACUUM POWER CYLINDER AIR CLEANER

The air cleaner used on all models covered by this manual is a plastic encased, synthetic element type filter and cleaning is NOT recommended. When cleaner becomes so laden with dirt, that tapping it against some solid surface (such as a work-bench) will not remove foreign matter, then a new cleaner should be installed.

The air cleaner on the tilt cab models is located on the backside of the front bumper near the vacuum power cylinder and is accessible by tilting cab forward (see fig. 14).

The air cleaner on the conventional models is located in the left rear corner of the cab, directly behind the driver's seat. To remove, unfasten nut and bolt holding cleaner to bracket and pull cleaner off air hose (see fig. 15).

VACUUM CHECK VALVE

On all vehicles with vacuum power assisted hydraulic brakes a check valve is used somewhere in the vacuum line between the engine intake manifold and the vacuum power cylinder (see fig. 16).

Purpose of check valve is to seal vacuum in power cylinder (and in vacuum reserve tank, when used), assuring sufficient vacuum for at least one power brake application in case the engine stalls.

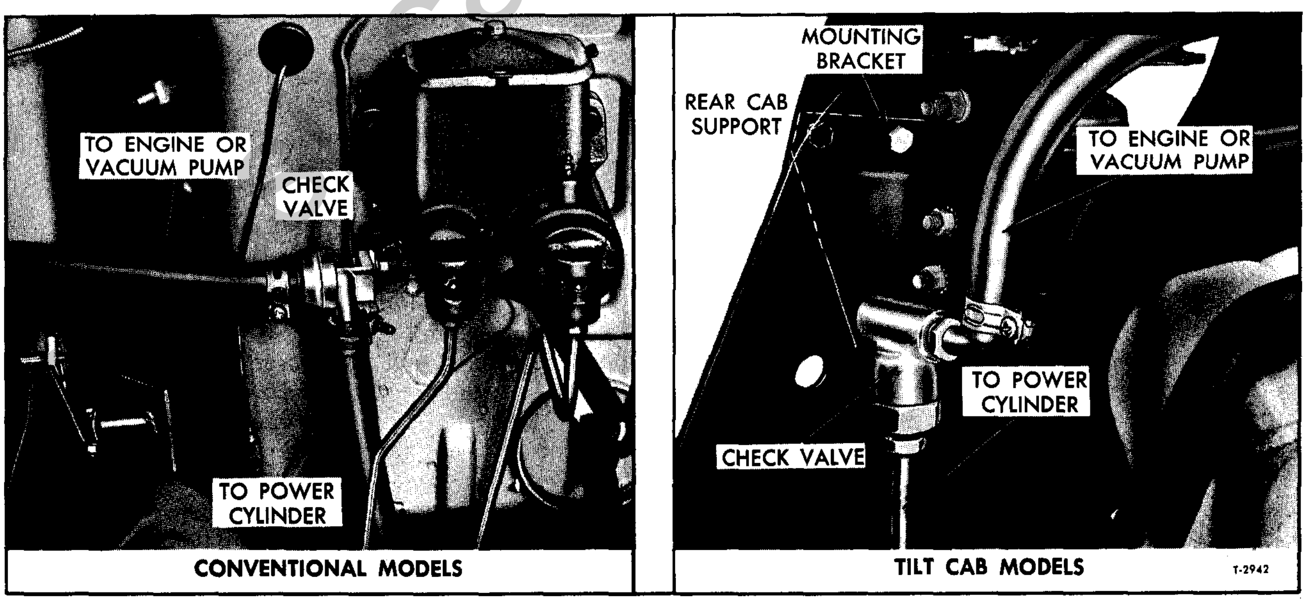


Figure 16—Vacuum Check Valves Installed

Check valve can be tested for leakage by disconnecting power cylinder vacuum line from valve fitting and connecting a vacuum gauge, using a length of hose between gauge and check valve. Start engine, run at idle for a few seconds, and note reading on gauge. Stop engine and observe rate of vacuum drop. If drop exceeds 1 inch in 15 seconds, leakage must be considered excessive, and check valve must be repaired or replaced.

There are two basically different type vacuum check valves used. One is repairable and one is not. The repairable type has a cast metal body and is used on all tilt cab model trucks. The non-repairable type has a sealed plastic body and is used on all conventional cab models.

Removal and installation of all valves is the same. Disconnect all lines and hoses and remove bolts or screws which fasten valve to vehicle. Discard malfunctioning valves removed from conventional cab models and replace with new valve. Valves removed from tilt cab models can be repaired.

Valve on conventional models is located in the engine compartment and is fastened to a bracket attached to the fire wall (see fig. 16).

Valve on the tilt cab model is fastened to a bracket which is bolted on cab rear support, inside the channel on left-hand side (see fig. 16).

VACUUM RESERVE TANK

A vacuum reserve tank is optional equipment on all models using vacuum assisted hydraulic brakes in series 70. Each tank has a minimum capacity of 1000 cubic inches and is installed in the vacuum line between the vacuum check valve and the power cylinder.

On conventional cab models, the tank is installed immediately below the left-hand door, behind the cab step along with the vacuum booster.

On tilt cab models, the tank is installed behind the engine, in front of the rear axle, and between frame side rails.

To replace tank, disconnect lines and brackets connecting tank to vehicle.

VACUUM GAUGE

There are several vacuum gauges used on vehicles covered by this manual. All operate on the same principle and all are factory set and sealed units which are not adjustable or repairable. If a gauge fails to operate or operates improperly, it must be replaced. Gauges differ in size, appearance and color dependent upon truck model. All are located in the instrument panel, some as units in a cluster and some as separate installations.

A vacuum gauge is optional equipment on all vehicles in series 70 with gasoline engines and vacuum power hydraulic brakes.

If a vacuum gauge is suspected of operating improperly it may be checked by comparing readings with a test gauge which is known to be accurate. Observe readings on vehicle gauge at engine idle speed and at various, specific engine rpm up to maximum. Install test gauge in convenient location in vacuum line and observe readings on test gauge at same specific engine rpm. Manufacturer specifications permit a variation of - 1 inch of mercury at 5 inches and -2 inches of mercury at 20 inches. Any variation beyond these limits is an indication that the vehicle vacuum gauge should be replaced. Before condemning a gauge which does not register, or registers improperly, make certain that all vacuum lines in the system are free of dirt and/or kinks and that all connections are tight. System leakage can result in registration on gauge which is not normal.

TYPE "F" FRONT BRAKES

(Refer to Figure 17)

Two identical brake shoes are arranged on backing plate so that their toes are diagonally opposite. Two single-end wheel cylinders are arranged so that each cylinder is mounted between the toe of one shoe and the heel of the other. The two wheel cylinder pistons apply an equal amount of force to the toe of each shoe. Each cylinder casting is shaped to provide an anchor block for the brake shoe heel.

Each shoe is adjusted by means of an eccentric cam which contacts a pin pressed into brake shoe web. Each cam is attached to the backing plate by a cam and shoe guide stud which protrudes through a slot in the shoe web and in conjunction with flat washers and C-washers, also serves as a shoe hold-down. Two return springs are connected between the shoes, one at each toe and heel.

With vehicle moving forward, both shoes are forward acting (primary shoes), self-energizing in forward direction of drum rotation. With vehicle in reverse, both shoes are reverse acting since neither is self-energized in the reverse direction of drum rotation.

BRAKE SHOE REMOVAL (Fig. 17)

1. Block wheels, jack up axle and remove hub and brake drum assembly as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D).
2. Remove both brake shoe return springs, using brake spring pliers.
3. Remove C-washer and flat washer from each adjusting cam and hold-down stud. Lift shoes off backing plate.

CLEANING AND INSPECTION

1. Clean all dirt out of brake drum. Inspect drum for roughness, scoring, or out-of-round. Replace or recondition brake drum as necessary. Refer to "Brake Drums" later in this section.
2. Inspect wheel bearings and oil seals as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D).
3. Check backing plate attaching bolts to make sure they are tight. Clean all dirt off backing plate.
4. Inspect brake shoe return springs. If broken, cracked, or weakened, replace with new springs.
5. Check cam and shoe guide stud and friction spring on backing plate for corrosion or binding. Cam stud should turn easily with an 8-inch wrench, but should not be loose. If frozen, lubricate with kerosene or penetrating oil and work free.
6. Examine brake shoe linings for wear. Linings should be replaced if worn down close to rivet heads. Refer to "Brake Shoe Relining" in this section.

BRAKE SHOE INSTALLATION

1. Install anti-rattle spring washer on each cam and shoe guide stud, pronged side facing adjusting cam.
2. Place shoe assembly on backing plate with cam and shoe guide stud inserted through hole in shoe web; locate toe in wheel cylinder piston shoe guide and position heel in slot in anchor block.
3. Install flat washer and C-washer on cam and shoe guide stud. Crimp ends of C-washer.
4. After installing both shoes, install brake shoe return spring. To install each spring, place spring end with short hook in toe of shoe, then using brake spring pliers, stretch spring and secure long hook end in heel of opposite shoe.
5. Install hub and brake drum as directed in "FRONT HUBS AND BEARINGS" (SEC. 3D) of this manual.
6. Adjust brake as previously directed under "Brake Adjustment."

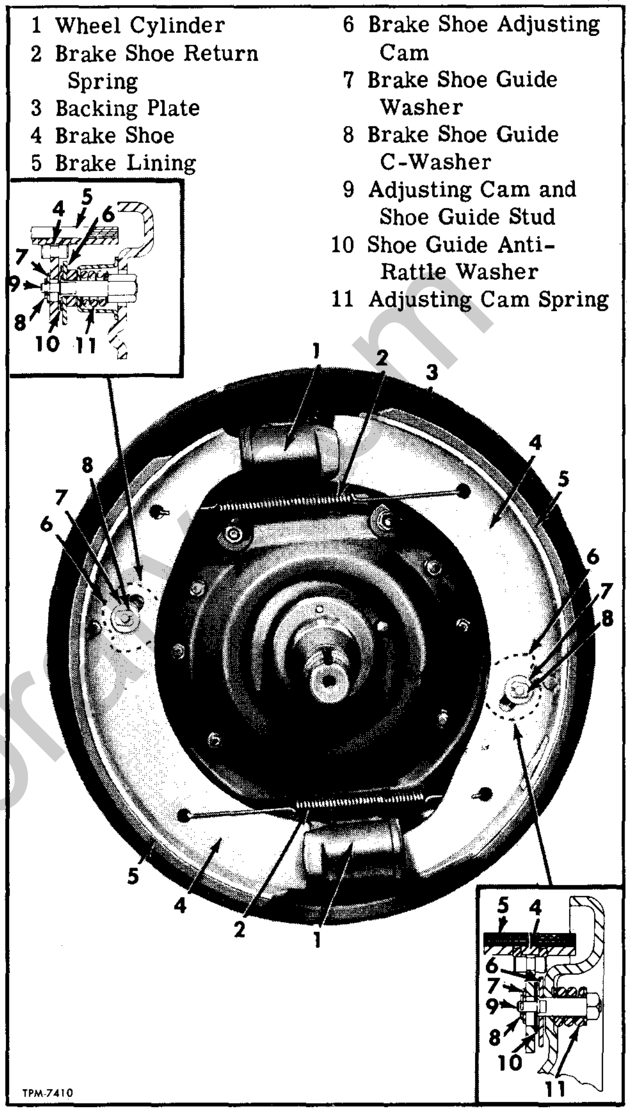
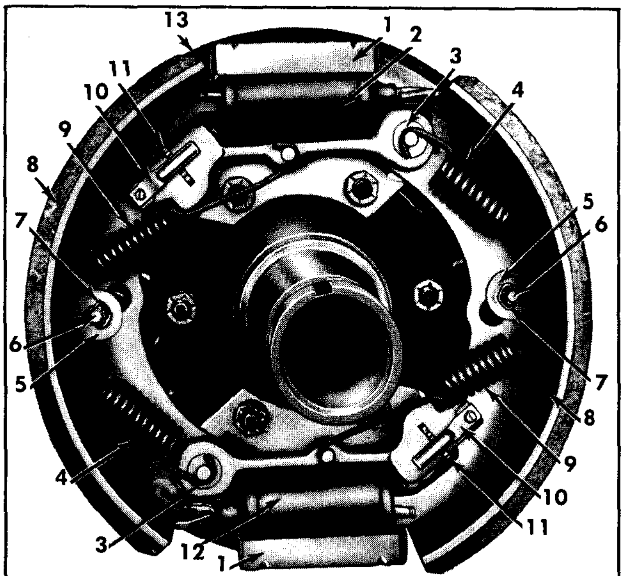


Figure 17—Type "F" Front Brake Assembly

TYPE "FR-3" REAR BRAKES

Each brake is equipped with two double-end wheel cylinders which apply hydraulic pressure to both the toe and the heel of two identical, self-centering shoes. The shoes anchor at either toe or heel, depending upon the direction of drum rotation. Brake anchor supports and backing plate are bolted to the axle housing flange. The supports have removable slotted anchor pins at the shoe heels, and adjusting screws at the shoe toes. Adjusting screws act as anchors in the reverse direction of rotation. Each adjusting screw is threaded into or out of its support by means of an adjusting wheel. Adjusting wheels are accessible through adjusting slots in the backing plate.



1 Wheel Cylinder Heat Shield
2 Upper Wheel Cylinder
3 Anchor Pin
4 Return Spring (Short)
5 Guide Washer
6 Guide Bolt
7 Guide Bolt Nut Lock Wire
8 Brake Shoe and Lining Assembly
9 Return Spring (Long)
10 Adjusting Wheel Lock Spring
11 Adjusting Wheel
12 Lower Wheel Cylinder
13 Backing Plate

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Figure 18—Type "FR-3" Rear Brake Assembly

BRAKE SHOE REMOVAL

1. Block wheels, jack up axle and remove hub and brake drum assembly as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) in this manual.

2. Install wheel cylinder clamps to hold pistons in cylinders.

3. Using special brake spring tool (J-22348), remove brake shoe return springs.

4. Remove lock wires, nuts, and washers from brake shoe guide bolts, then remove brake shoe assemblies.

5. Remove screws attaching adjusting wheel lock springs to anchor supports. Thread each adjusting screw from the shoe side of its anchor support by turning adjusting wheels, then lift adjusting wheels out of slots in anchor supports.

CLEANING AND INSPECTION

1. Clean all dirt out of brake drum. Inspect drum for roughness, scoring, or out-of-round. Recondition or replace drum as necessary. Refer to "Brake Drums" in this section.

2. Clean all dirt out of anchor pin holes and adjusting screw openings in anchor supports.

3. Inspect wheel bearings and oil seals as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

4. Inspect brake shoe return springs. If broken, cracked, or weakened, replace with new springs.

5. Inspect threads on adjusting screws and in adjusting wheels for wear or damage. Replace as necessary.

6. Examine brake shoe linings for wear. Linings should be replaced if worn down close to rivet heads. Refer to "Brake Shoe Relining" in this section.

7. Inspect backing plate for cracks or distortion. Replace if defective.

BRAKE SHOE INSTALLATION

1. Install adjusting screws and wheels in anchor supports dry; use no lubricant. Insert each adjusting wheel in slot in anchor support, insert threaded end of adjusting screw in anchor support, then turn adjusting wheel to thread adjusting screw into anchor support. Insert anchor pins into holes in anchor supports, with slots in pins facing slots in supports.

2. Install brake shoes with cut-away end of shoe web next to adjusting screw and with ends of shoes engaging slots in wheel cylinder push rods and anchor pins. Install flat washer and nut on each brake shoe guide bolt. Tighten nuts finger-tight, then back off nuts only far enough to allow movement of shoes without binding.

3. Install brake shoe return springs, hooking one end of each spring in brake shoe web, then hook other end over anchor pins with special brake spring tool (J-22348).

4. Remove wheel cylinder clamps.

5. Install hub and brake drum assembly as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

6. Adjust brakes as directed under "Brake Adjustments."

TYPE "FR-3A" REAR BRAKES

The type "FR-3A" rear brake is the same as the type "FR-3" brake except for method of adjustment. The type "FR-3A" brake has an automatic adjusting mechanism. Refer to figure 19.

Brake shoe adjustment takes place when the brakes are applied with firm pedal effort while vehicle is backing up. When brakes are applied (backing up) the heel of the brake shoe moves away from the forward-acting anchor, an action which places a cocking motion in the link-crank system. An adjustable eccentric on the shoe web provides a hinge for a short link which carries this motion to an adjuster crank fastened on the forward acting anchor pin by a C-washer. From the adjuster crank, motion transfers through the long link to the star wheel crank assembly mounted on the opposite anchor bracket so that a pawl on the crank meshes with the star wheel. The motion pivots (cocks) the crank back, the force overcoming the adjuster spring connected between a finger of the crank and the brake shoe return spring pin. If the lining clearance permits sufficient movement, the crank pawl picks up the next tooth on the star wheel.

Unintentional back-off of the star wheel is prevented by a friction ring located on the star wheel screw. This ring applies sufficient drag to prevent an automatic back-off, but not enough to prevent manual adjustments at the star wheel.

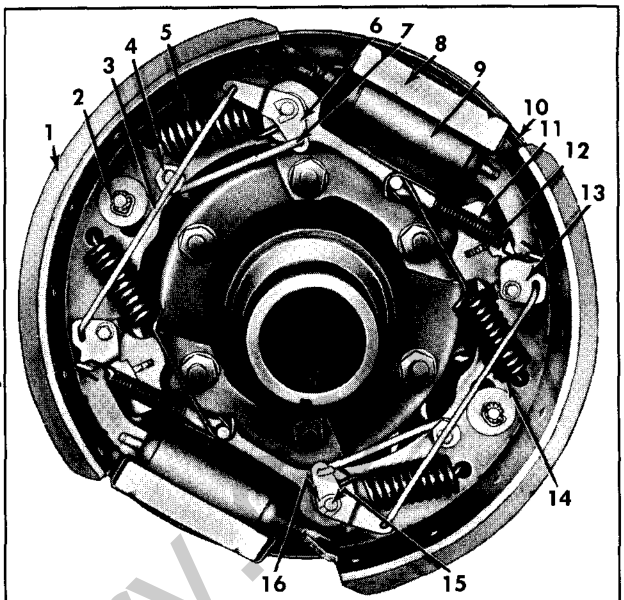
Automatic adjustment is completed upon brake release, as the adjuster spring returns the star wheel crank, advancing the star wheel one tooth. Completion may be delayed by anchoring pressure against the star wheel screw; in this case, it is completed as the anchor pressure is relieved by the next forward brake application.

BRAKE SHOE REMOVAL
(Refer to Fig. 20)

1. Block wheels, jack up axle and remove hub and brake drum assembly as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual. It may be necessary to back off adjuster star wheels slightly to free grooved drums.

CAUTION: DO NOT back off adjustment so much that star wheel is jammed against the friction ring on the star wheel screw; this may damage the friction ring.

2. Unhook the two automatic adjuster springs.
3. Remove the two long crank links by pivoting back the star wheel cranks until their slots align with the link "U" hooks. Lift out links, then slide their "S" hooks from the adjuster cranks.
4. Remove short crank links by rotating adjuster cranks until link "U" hooks clear the eccentrics on shoe webs, then remove the smaller "U" hooks from the adjuster cranks.
5. Spread adjuster crank C-washers and lift off cranks.
6. Remove bolt which fastens star wheel crank to anchor support and remove crank.
7. Remove adjuster eccentric screw and eccentric from brake shoe.
8. Remove two long shoe return springs and two short return springs by sliding looped ends off pins.
9. Remove lock wires, hold-down nuts, and washers from hold-down bolts and lift off brake shoes.



1 Brake Shoe and Lining Assembly	8 Wheel Cylinder Cover
2 Hold-down Bolt, Washer, Nut, and Lock Wire	9 Wheel Cylinder
	10 Backing Plate
	11 Adjuster Spring
3 Crank Link (Long)	12 Starwheel
4 Eccentric and Screw	13 Starwheel Crank
5 Shoe Return Spring (Short)	14 Shoe Return Spring (Long)
6 Adjuster Crank	15 Anchor Pin
7 Crank Link (Short)	16 "C" Washer

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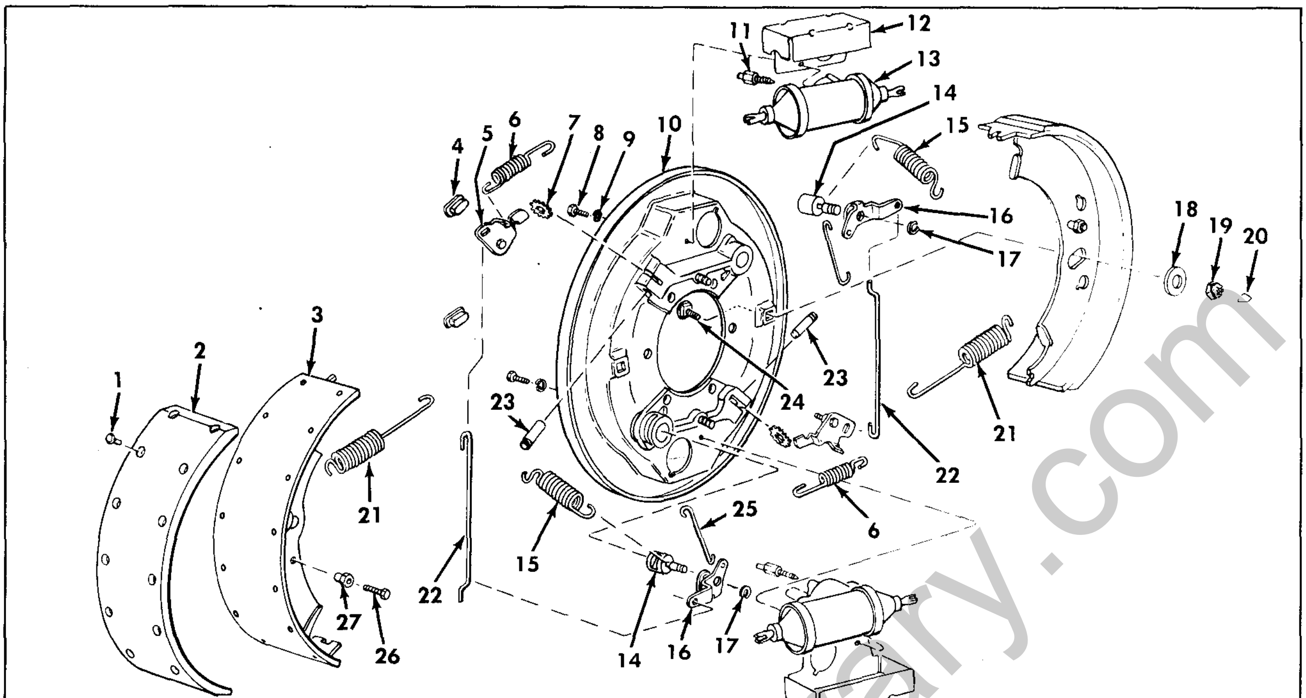
Figure 19—Type "FR-3A" Rear Brake Installed

10. Thread each star wheel screw out of anchor support from shoe side of support. Lift star wheels from support slots.

NOTE: DO NOT attempt to remove a friction ring from a star wheel screw; if necessary, replace with a new screw and friction ring assembly.

CLEANING AND INSPECTION

1. Clean all dirt out of brake drum. Inspect drum for roughness, scoring, or out-of-round. Recondition or replace drum as necessary. Refer to "Brake Drums" in this section.
2. Clean all dirt out of anchor pin holes and adjusting screw openings in anchor supports.
3. Inspect wheel bearings and oil seals as directed in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.
4. Inspect brake shoe return springs. If they are broken, cracked, or weakened, replace with new springs.
5. Inspect threads on adjusting screws and in adjusting wheels for wear or damage. Replace as necessary.
6. Check all automatic adjuster components and replace any which are worn or damaged. Replace springs if broken, cracked, or weakened.



1 Rivet	10 Backing Plate	19 Hold-down Nut
2 Brake Lining	11 Bleeder Valve	20 Lock Wire
3 Brake Shoe	12 Wheel Cylinder Cover	21 Shoe Return Spring (Long)
4 Hole Cover	13 Wheel Cylinder	22 Crank Link (Long)
5 Starwheel Crank	14 Anchor Pin	23 Starwheel Screw
6 Adjuster Spring	15 Shoe Return Spring (Short)	24 Hold-down Bolt
7 Starwheel	16 Adjuster Crank	25 Crank Link (Short)
8 Bolt	17 C-washer	26 Eccentric Screw
9 Spring Washer	18 Hold-down Washer	27 Eccentric

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Figure 20—Type "FR-3A" Rear Brake Components

7. Check wheel cylinders as instructed under "Wheel Cylinder Repair" in this section. Replace with new cylinders if necessary.

8. Examine brake shoe linings for wear. Linings should be replaced if worn down close to rivet heads. Refer to "Brake Shoe Relining" in this section.

BRAKE SHOE INSTALLATION

1. Insert star wheels in anchor support slots and thread in star wheel screw from the shoe side, friction ring end toward the shoe. For new linings, back off screws, taking care to not jam star wheels.

NOTE: DO NOT LUBRICATE STAR WHEEL SCREWS.

2. Position one brake shoe with its "toe" (cut-away portion of web) located in the adjuster slot and the "heel" in the anchor pin slot of anchor supports.

3. Install brake shoe hold-down bolt, hold-down washer and hold-down nut. Tighten nut finger-tight and then back off nut one turn and insert nut lock wire.

4. Install the other brake shoe in same manner as described in paragraphs 2 and 3.

5. Install long brake shoe return springs in shoe web, longest shank at adjuster, and hook springs over pins.

6. Install short brake shoe return springs in shoe web and hook springs over pins at anchor end.

7. Place adjuster eccentrics on shoe webs and fasten with self-tapping screw. Tighten screw only finger-tight to permit final adjustment later.

8. Place adjuster cranks on anchor pins, their long arms toward shoes, bushing toward backing plate, so that they rotate freely while resting against return spring hooks.

9. Install and crimp adjuster crank C-washer.

10. Place star wheel crank on anchor support and fasten with crank bolt.

11. At each adjuster crank assemble the short link small hook into the short arm of the crank from the lower side and hook the other end of link around the eccentric on the shoe web.

12. Assemble long link "S" hook to long arm

of adjuster crank from upper side, rotate star wheel crank so that slot lines up with link "U" hook. Insert "U" hook and rotate star wheel crank back to approximate adjusting position.

13. Install adjuster spring with short hook on star wheel crank finger so that its long shank hook assembles on the outer groove of the pin from the wheel cylinder side.

INITIAL MANUAL LINING ADJUSTMENT

1. If shoes have been relined, back off star wheel adjustments.

2. Center each shoe; insert a pry tool against backing plate curl and shoe (do not mar lining). Slide shoe up or down in anchor slots until leading and trailing edges of the lining are equidistant from the inner curl of the brake backing plate.

3. On each shoe web, rotate hex eccentric, as required, until linkage aligns star wheel crankpawl with center line of star wheel screw. A SMALL DRILL POINT RECESS ON THE ANCHOR SUPPORT IS THE ALIGNING MARK.

4. When aligned, lock eccentrics by tightening self-tapping screws to 19 foot-pounds torque.

5. Install hub and drum as described in "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual.

6. Remove both adjustment slot covers from back of backing plate.

7. Insert adjusting tool and turn each star wheel until lining drags on drum while drum is rotated. To tighten adjustment, move tool handle toward axle while using inner side of adjuster slot as fulcrum for the tool, rotating the star wheel teeth away from the axle.

8. Back off star wheels while rotating drum forward, until drag is just relieved. Provide additional running clearance by backing off 8 to 10 more notches and replace slot covers. Automatic adjustment now takes over.

BRAKE SHOE RELINING

Brake linings on most models are riveted to the brake shoes and may be replaced. These linings may be purchased in replacement sets of four linings and sufficient rivets of correct specifications. Refer to Parts Book for lining replacement kits. When replacing linings, make sure that shoes are clean and that linings are installed in a manner that will prevent gaps between lining and shoe.

Conventional lining replacement equipment should be used. Make sure lining fits firmly against shoe, and that rivets are properly upset.

NOTE: Whenever brake drums have been refinished it is advisable to have linings ground to fit individual drums.

BRAKE DRUMS

Brake drum installations are illustrated in "FRONT HUBS AND BEARINGS" (SEC. 3D) and "REAR HUBS AND BEARINGS" (SEC. 4C) of this manual. Procedures for replacing brake drums are also included in the previously mentioned sections.

Whenever brake drums are removed for servicing brakes, inspect drums. If found to be scored, rough, or out-of-round, drums should be machined.

Machining or grinding of brake drums increases the inside diameter of the drum and changes the lining to drum fit. When machining drums, it is recommended that the following maximum oversizes not be exceeded:

(a) Drums with standard diameter up to 14" can be machined up to 0.060" oversize.
(b) Drums with standard diameter over 14" can be machined up to 0.080" oversize.

When it is found that machining to these maximum limits does not provide a suitable braking surface, discard the worn drum and replace with a new standard drum.

DO NOT EXCEED THESE LIMITS. THIS IS A SAFETY PRECAUTION.

TROUBLESHOOTING CHART

LOW PEDAL OR PEDAL GOES TO TOE BOARD PROBABLE CAUSE	REMEDY
1. Excessive clearance between linings and drum.	1. Adjust brakes.
2. Weak brake hose.	2. Replace with new hose.
3. Leaking conduits.	3. Repair or replace faulty parts.
4. Leaking wheel cylinder.	4. Clean and rebuild.
5. Leaking master cylinder.	5. Clean and rebuild.
6. Leaking master cylinder check valve.	6. Install new check valve.
7. Air in system.	7. Bleed system.
8. Plugged master cylinder filler cap.	8. Clean filler cap vent holes; bleed system.
9. Improper brake fluid.	9. Flush system and refill with recommended brake fluid.
10. Low fluid level	10. Fill reservoir with brake fluid; bleed system.

SPRINGY, SPONGY PEDAL PROBABLE CAUSE	REMEDY
1. Air trapped in hydraulic system.	1. Remove air by bleeding.
2. Improper brake fluid.	2. Flush, refill and bleed system. Use recommended brake fluid.
3. Improper lining thickness or location.	3. Install specified lining or replace shoe and lining.
4. Drums worn too thin.	4. Replace drums.
5. Master cylinder filler vent clogged.	5. Clean vent or replace cap; bleed brakes.
6. Weak hose.	6. Install new hose.

EXCESSIVE PEDAL PRESSURE REQUIRED TO STOP PROBABLE CAUSE	REMEDY
1. Brake adjustment not correct.	1. Adjust the brakes.
2. Incorrect lining.	2. Install specified linings.
3. Grease or fluid soaked lining.	3. Repair grease seal or wheel cylinder. Install new linings.
4. Lining not in full contact.	4. Grind lining to proper radius.
5. Improper fluid.	5. Flush out system; fill with recommended fluid; bleed.
6. Frozen master or wheel cylinder pistons.	6. Recondition or replace all cylinders.
7. Brake pedal binding on shaft.	7. Lubricate.
8. Glazed linings.	8. Sand surface of linings.
9. Bellmouthed, barrel-shaped or scored drums.	9. Replace or resurface drums in R.H. and L.H. pairs.

LIGHT PEDAL PRESSURE -- BRAKES TOO SEVERE PROBABLE CAUSE	REMEDY
1. Brake adjustment not correct.	1. Adjust the brakes.
2. Loose backing plate on front axle.	2. Tighten plates.
3. A small amount of grease or fluid on linings.	3. Replace the linings.
4. Charred linings.	4. Sand the surfaces of the linings.
5. Incorrect lining.	5. Install factory specified linings.
6. Wheel bearings loose.	6. Adjust wheel bearings.
7. Lining loose on shoe.	7. Replace lining or shoe and lining.
8. Excessive dust and dirt in drums.	8. Clean and sand drums and linings.
9. Bad drum.	9. Turn drums in pairs or replace.

BRAKE PEDAL TRAVEL DECREASING PROBABLE CAUSE	REMEDY
1. Master cylinder compensating port plugged.	1. Open, use air or .015 wire. Remove any burr in bore.
2. Swollen cup in master cylinder.	2. Replace rubber parts flush system. Refill with recommended fluid.
3. Master cylinder piston not returning.	3. Rebuild master cylinder.
4. Weak shoe retracting springs.	4. Replace springs.
5. Wheel cylinder pistons sticking.	5. Clean cylinder bores and parts. Replace bad parts.

PULSATING BRAKE PEDAL PROBABLE CAUSE	REMEDY
1. Drums out-of-round.	1. Refinish drums.
2. Loose brake drums on hub.	2. Tighten.
3. Worn or loose wheel bearings.	3. Replace or adjust.
4. Bent rear axle.	4. Replace axle.

BRAKES FADE PROBABLE CAUSE	REMEDY
1. Incorrect lining.	1. Replace lining with lining recommended.
2. Poor lining contact.	2. Grind lining to proper radius, adjust.
3. Thin drum.	3. Replace drum.
4. Dragging brakes.	4. Adjust.

ALL BRAKES DRAG WHEN ADJUSTMENT IS KNOWN TO BE CORRECT	
PROBABLE CAUSE	REMEDY
1. Pedal does not return to stop.	1. Lubricate the pedal.
2. Improper fluid.	2. Replace rubber parts and fill with recommended brake fluid.
3. Compressing or bypass port of master cylinder closed.	3. Open by air or .015 wire. Remove any burr in bore.
4. Use of inferior rubber parts.	4. Install proper parts.

ONE WHEEL DRAGS	
PROBABLE CAUSE	REMEDY
1. Weak or broken shoe retracting springs.	1. Replace the defective brake shoe springs and lubricate the brake shoe ledges.
2. Brake shoe to drum clearance too small or the brake shoe eccentric is not adjusted properly.	2. Adjust.
3. Loose wheel bearings.	3. Adjust wheel bearings.
4. Wheel cylinder piston cups swollen and distorted or the piston stuck.	4. Rebuild cylinders.
5. Pistons sticking in wheel cylinder.	5. Clean or replace pistons; clean cylinder bore.
6. Drum out-of-round.	6. Grind or turn both front or rear drums.
7. Obstruction in line.	7. Clean out or replace.
8. Distorted shoe.	8. Replace.
9. Defective lining.	9. Replace with specified lining.

REAR BRAKES DRAG	
PROBABLE CAUSE	REMEDY
1. Maladjustment.	1. Adjust brake shoes.

PULLS TO ONE SIDE	
PROBABLE CAUSE	REMEDY
1. Grease or fluid soaked lining.	1. Replace with new linings.
2. Loose wheel bearings, loose backing plate on rear axle or front axle or loose spring bolts.	2. Adjust the wheel bearing, tighten the backing plate on the rear and front axles and tighten spring bolts.
3. Linings not of specified kind.	3. Install specified linings.
4. Tires not properly inflated or unequal wear of tread. Different tread non-skid design.	4. Inflate the tires to recommended pressures. Rearrange the tires so that a pair of non-skid tread surfaces of similar design and equal wear will be installed on the front wheels, and another pair with like tread will be installed on the rear wheels.
5. Linings charred.	5. Sand the surfaces of the lining.
6. Water, mud, etc., in brakes.	6. Remove any foreign material from all of the brake parts and inside of the drums. Lubricate the shoe ledges.

PULLS TO ONE SIDE (Cont'd.)	
PROBABLE CAUSE	REMEDY
7. Wheel cylinder sticking.	7. Repair or replace wheel cylinder.
8. Weak or broken retracting springs.	8. Check springs -- replace bent, open-coiled or cracked springs.
9. Out-of-round drums.	9. Resurface or replace drums in left- and right-hand pairs (both front and both rear).
10. Brake dragging.	10. Check for loose lining. Adjust.
11. Weak chassis springs, loose U-bolts, loose steering gear, etc.	11. Replace spring, tighten U-bolts, adjust steering gear, etc.
12. Loose steering.	12. Repair and adjust.
13. Unequal camber.	13. Adjust to specifications.
14. Clogged or crimped hydraulic line.	14. Repair or replace line.
15. Wheel cylinder size different on opposite sides.	15. Replace with correct cylinders.
16. Loose king pin.	16. Replace king pins or bushings.
17. Bad drum.	17. Refinish drums in pairs.

ONE WHEEL LOCKS	
PROBABLE CAUSE	REMEDY
1. Gummy lining.	1. Reline.
2. Tire tread slick.	2. Match up tire treads from side to side.

WET WEATHER: BRAKES GRAB OR WONT HOLD	
PROBABLE CAUSE	REMEDY
1. Linings too sensitive to water.	1. Reline.
2. Dirty brakes.	2. Clean out.
3. Bent backing plate.	3. Straighten.
4. Scored drums.	4. Grind or turn in pairs.

BRAKES SQUEAK	
PROBABLE CAUSE	REMEDY
1. Backing plate bent or shoes twisted.	1. Straighten or replace damaged parts.
2. Metallic particles or dust imbedded in lining.	2. Sand the surfaces of the linings and drums. Remove all particles of metal that may be found in the surfaces of the linings.
3. Lining rivets loose or lining not held tightly against the shoe at the ends.	3. Replace rivets and/or tighten lining by re-riveting.
4. Drums not square or distorted.	4. Turn or grind or replace drums.
5. Incorrect lining.	5. Replace lining.
6. Shoes scraping on backing plate ledges.	6. Apply brake lube to ledges. Replace with new shoe and linings, if distorted.
7. Weak or broken hold down springs.	7. Replace defective parts.
8. Loose wheel bearings.	8. Tighten to proper setting.
9. Loose backing plate, drum, wheel cylinder.	9. Tighten.

BRAKES CHATTER PROBABLE CAUSE	REMEDY
1. Incorrect lining to drum clearance.	1. Readjust to recommended clearances.
2. Loose backing plate.	2. Tighten securely.
3. Grease, fluid, road dust on lining.	3. Clean or reline.
4. Weak or broken retractor spring.	4. Replace.
5. Loose wheel bearings.	5. Readjust.
6. Drums out-of-round.	6. Grind or turn drums in pairs.
7. Cocked or distorted shoes.	7. Straighten or replace.
8. Tapered or barrel-shaped drums.	8. Grind or turn in pairs.

SHOE CLICK PROBABLE CAUSE	REMEDY
1. Shoes lift off backing plate and snap back.	1. Change drums side to side or grind drums (in pairs).
2. Hold down springs weak.	2. Replace springs.
3. Shoe bent.	3. Straighten.
4. Grooves in backing plate pads.	4. Grind and lubricate.

TROUBLE SHOOTING POWER HYDRAULIC BRAKES (Vacuum Assist Units)

NOTE: The same types of brake troubles are encountered with power brakes as with standard brakes. Before checking the power brake system for source of trouble, refer to trouble diagnosis of standard hydraulic brakes. After these possible causes have been eliminated, check for cause as outlined below.

NOTE: Make the following test before checking hard pedal for the cause. With the engine stopped, depress the brake pedal several times to eliminate all vacuum from the system. Apply the brakes, and while holding the foot pressure on the brake pedal, start the engine. If the unit is operating correctly, the brake pedal will move forward when the engine vacuum power is added to the pedal pressure. If this test shows that the power unit is not operating, the trouble may be one of the following:

BRAKE SYSTEM LOSES FLUID PROBABLE CAUSE	REMEDY
1. External Leak: Leaking-pipe connections, hose, wheel cylinders, master cylinder head nut, etc.	1. Clean parts. Replace defective parts. Tighten.
2. Internal Leaks: Past secondary seals into power unit. Check vacuum hose for fluid.	2. Rebuild master cylinder.

NO BOOST -- HARD PEDAL PROBABLE CAUSE	REMEDY
1. Bent, broken obstructed tube. Collapsed hose.	1. Replace defective parts.
2. Stuck check valve.	2. Replace valve.

NO BOOST -- HARD PEDAL (Cont'd.) PROBABLE CAUSE	REMEDY
3. Air inlet blocked.	3. Replace filter. Open passages.
4. Air valve stuck.	4. Disassemble unit -- clean -- replace defective parts.
5. Faulty diaphragm.	5. Replace diaphragm.
6. Faulty piston seal.	6. Replace seal.
7. Leaks internally.	7. Rebuild.
8. Leaking vacuum tank.	8. Repair tank.

SLOW BRAKE PEDAL RETURN PROBABLE CAUSE	REMEDY
1. Excessive seal friction in power unit.	1. Rebuild unit.
2. Faulty valve action.	2. Rebuild unit.
3. Broken return spring.	3. Replace spring.

BRAKES GRABBY PROBABLE CAUSE	REMEDY
1. Broken valve spring.	1. Rebuild unit.
2. Sticking vacuum valve.	2. Clean and lubricate.
3. Reaction diaphragm leakage.	3. Rebuild unit.

Only heavy-duty Hydraulic Brake Fluid as specified in LUBRICATION (SEC. 0) should be used in the hydraulic brake system. The use of other fluids may cause deterioration of rubber cups in master and wheel cylinders, and may induce corrosion of the metal parts of the cylinders.

SPECIFICATIONS

FRONT BRAKES

TRUCK SERIES	H AND T70	J70
Type	Type "F"	Type "F"
Adjustment	Manual	Manual
Size	15 x 3	15 x 3½
Lining Width	3"	3½"
Lining Thickness	5/16"	5/16"
Lining Area—Sq. In. per axle	199.0	231.1

REAR BRAKES

TRUCK SERIES	H AND T70	J70
Type	"FR-3"	"FR-3"
Adjustment	Manual	Manual
Size	15 x 7	15 x 6
Lining Width	7"	6"
Lining Thickness	½"	½"
Lining Area—Sq. In. per axle	440.0	379.6

BRAKE CONTROLS

TRUCK SERIES	H70	T70	J70
Wheel Cylinder Bore—Front	1⅛"	1⅛"	1¼"
Rear	1¾"	1¾"	1⅝"
Master Cylinder Bore	1¾"	1¾"	1¾"

POWER CYLINDERS

TRUCK SERIES	H70	J70	T70
Power Cylinder Model No.	C-4042-B	C-4036-A	C-4058
Type	Tandem Diaph.	Tandem Diaph.	Tandem Diaph.
Overall Diameter	11.70"	11.70"	11.70"
Diaphragm Stroke	2.90"	4.25"	2.90"
Slave Cylinder Bore	1.19"	1.19"	1.19"
Displacement	3.2 cu. in.	4.7 cu. in.	3.2 cu. in.

AIR BRAKES

BRAKE SYSTEM EQUIPMENT

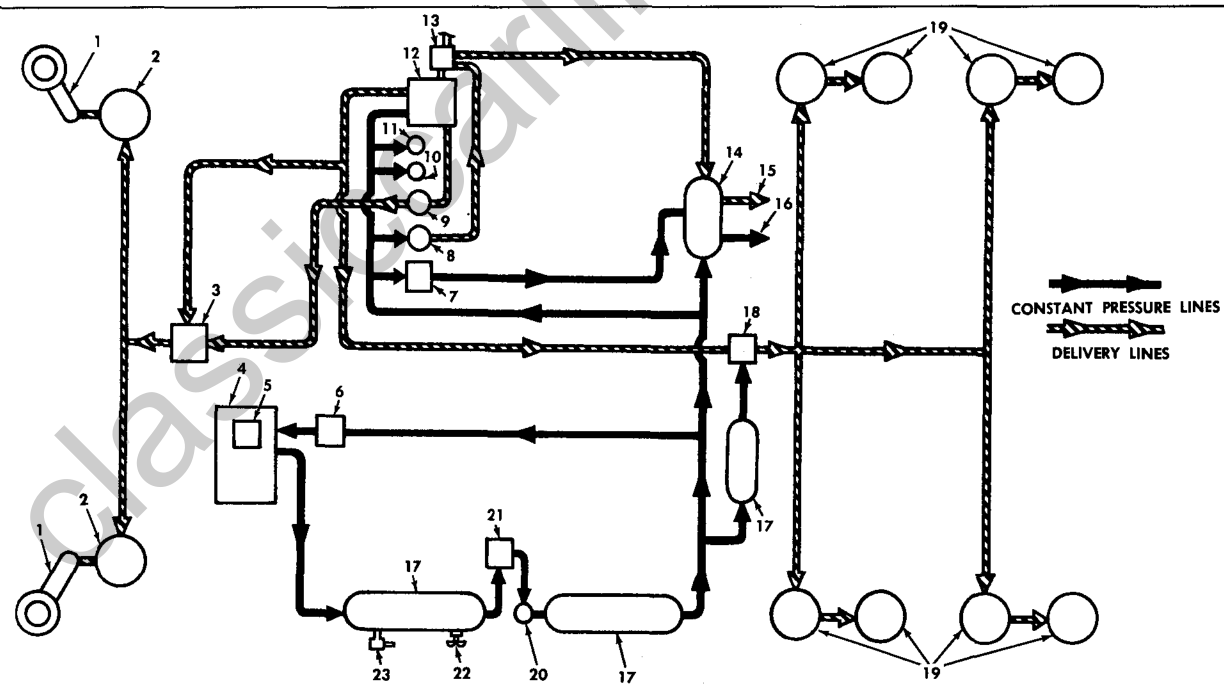
The air brake system comprises a group of devices, some of which maintain a supply of compressed air, some of which direct and control the flow of the compressed air, and others which transform the energy of compressed air into the mechanical force and motion necessary to apply the brakes. Refer to figure 1 for typical schematic diagram.

Information in this section covers all standard air brake equipment, as well as other units which are used as optional equipment on some models.

There are two basically different types of air actuated brakes used on vehicles covered by this manual. One is the cam-type brake which is energized by an air chamber and slack adjuster arrangement. The other is called Stopmaster, which is a complete assembly consisting of two air chambers connected to two brake shoes through tubes containing push-rod and plunger assemblies. All information relative to Stopmaster brakes is found under the heading of "Stopmaster Brakes" in this section. Unless otherwise specified, all pedals, valves, controls, etc., covered in this manual apply to both cam-type and Stopmaster type brake systems.

BRAKE SYSTEM MAINTENANCE

Normal operation of braking system necessitates periodic tests, inspection, and adjustments to assure safe, efficient operation. Test, inspection, and adjustment procedures for each air brake control unit are described under individual headings in this section. Since the vehicles covered by this Service Manual will be used in a wide variety of operation types, it is impossible to fix maintenance intervals (either time or mileage) which will satisfactorily suit all conditions. Therefore, any such intervals stated in these maintenance procedures must be related to the type of usage to which a particular vehicle is put. Obviously, a truck used



1 Slack Adjuster
2 Standard Brake Chamber
3 Limiting and Quick Release Valve
4 Air Compressor
5 Air Intake
6 Governor
7 Emergency/Parking "Push-Pull" Valve
8 Trailer Brake Hand Control Valve
9 Two-Way Valve
10 Low Air Buzzer Switch
11 Air Gauge
12 Application Valve
13 Double Check Valve
14 Tractor Protection Valve
15 Trailer Brake Service Line
16 Trailer Brake Emergency Line
17 Air Tanks
18 Relay Valve
19 Stopmaster Brake Chambers
20 Check Valve
21 Moisture Ejector Valve
22 Drain Valve
23 Safety Valve

T-2344

Figure 1—Schematic Diagram of Typical Air Brake System

in city "stop and start" driving will require different service operations and intervals than one hauling "over the road" for long distance. With this in mind, all service intervals should be related to a specific vehicle.

Compression and subsequent cooling of air causes the moisture in the air to condense. This moisture collects in air tank and should be drained daily. Drain cocks are provided at bottom of air tanks for this purpose. Satisfactory draining is accomplished only by leaving the drain cocks open after compressed air has escaped and until all drainage stops.

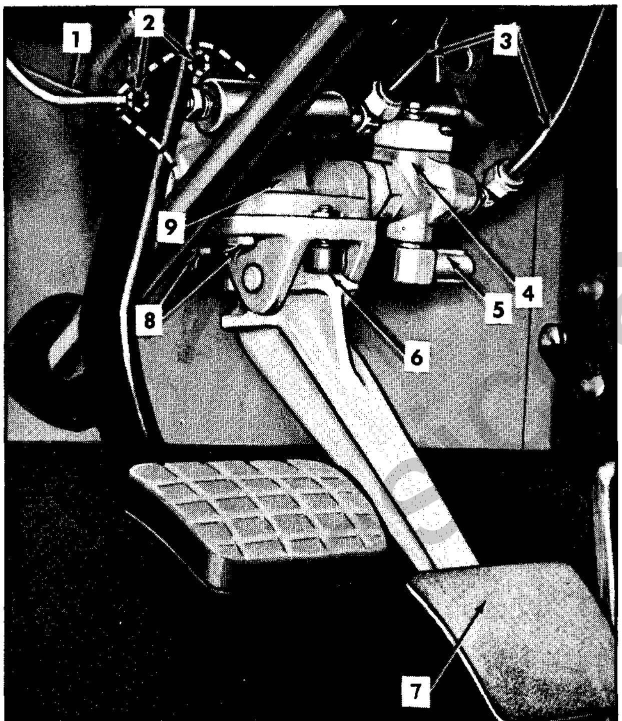
Some vehicles are equipped with a moisture ejector valve (optional), which eliminates the need for daily drainage of air tanks. For description of how this valve works, refer to procedures under heading of "Moisture Ejector Valve."

The complete air system should be checked for leakage at regular intervals. Build up air pressure in system to governor cut-out point, then with engine stopped and brakes released, observe rate of air pressure drop registered by the dash air pressure drop registered by the dash air pressure gauge. The rate of drop should not exceed two pounds per minute. With engine stopped and brakes fully applied, observe rate of air pressure drop registered by the dash gauge. Rate of drop should not exceed three pounds per minute. If leakage is excessive, leakage test should be made at air line connections and at all air brake control units as directed under individual headings later in this section.

In cold weather, particular attention should be given to draining of moisture from air system.

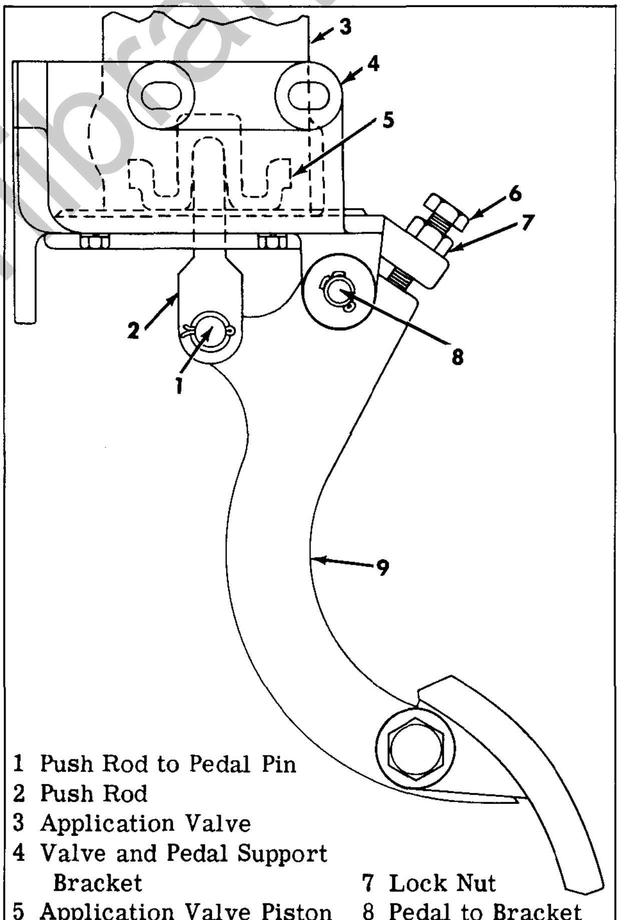
BRAKE ADJUSTMENTS

Brake adjustments to compensate for normal lining wear are made at slack adjuster at each wheel. Adjustment must be made before push rod travel reaches the maximum working stroke.



1 Line to Air Gauge
2 Valve Mounting Bolt and Nut (in Engine Compartment)
3 Lines to Trailer Brakes Hand Control Valve
4 Double Check Valve and Stop Light Switch
5 Line to Tractor Protection Valve
6 Pedal Stop Button
7 Pedal Assembly
8 Pedal to Valve Bolts
9 Application Valve Assembly T-2126

Figure 2—Brake Pedal and Application Valve Installed (Conventional Cab—Typical)



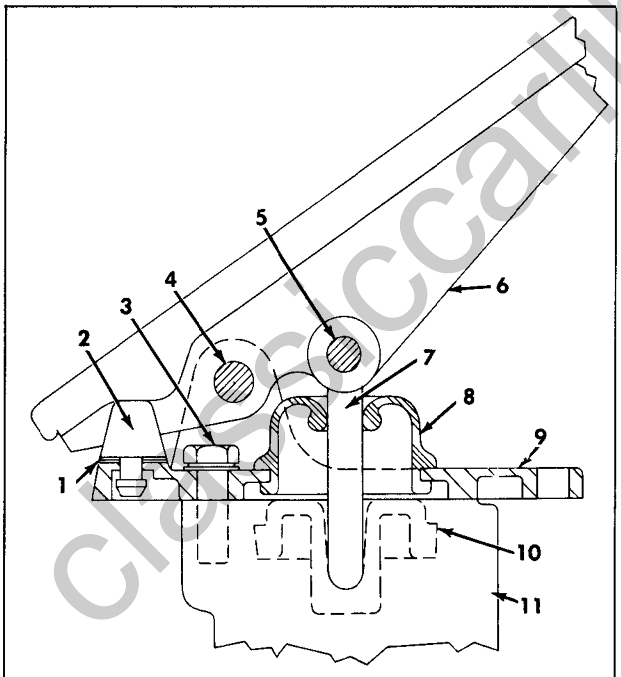
1 Push Rod to Pedal Pin
2 Push Rod
3 Application Valve
4 Valve and Pedal Support Bracket
5 Application Valve Piston Cup
6 Pedal Stop Screw
7 Lock Nut
8 Pedal to Bracket Pin
9 Pedal T-1563

Figure 3—Brake Pedal and Linkage (Tilt Cab)

PEDAL STOP SCREW ADJUSTMENT
(CONVENTIONAL MODELS - Fig. 2)

On 70, 80, and 90 conventional models, both Midland-Ross and Bendix-Westinghouse application valves (pedal assembly included) are used. Midland-Ross has a stop screw and Bendix-Westinghouse has a stop button as part of the assembly. This stop screw, or button, is used to adjust pedal to provide proper pedal travel. If travel is too great, application will be too slow and full application may not be obtained. If travel is not great enough, brakes may not release completely. Adjust stop screw (button) as follows:

1. Loosen lock nut.
2. Turn stop screw (M-R) into pedal bracket until pedal roller does not touch exposed end of valve piston; or (B-W) until plunger does not touch valve piston.
3. Turn stop screw (M-R) out of pedal bracket until roller JUST TOUCHES exposed end of valve piston; or (B-W) until plunger JUST TOUCHES valve piston. In other words, there should be NO FREE PLAY between pedal and valve piston.
4. Tighten lock nut without moving stop screw (or button).
5. Check brakes for application and release.



1 Shims
2 Treadle Stop Bumper
3 Mounting Plate to Application Valve Bolt
4 Treadle Pin
5 Push Rod Pin
6 Treadle
7 Push Rod
8 Push Rod Boot
9 Mounting Plate
10 Application Valve Piston Cup
11 Application Valve

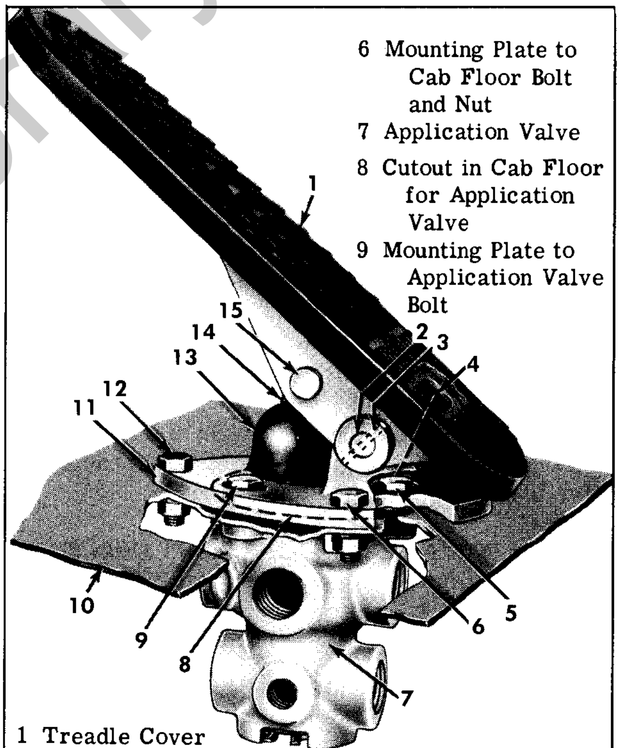
TPM-7583

Figure 4—Brake Treadle Installation

PEDAL STOP SCREW ADJUSTMENT
(TILT CAB MODELS - Fig. 3)

Pedal stop screw adjustment controls the exhaust opening between the hollow end of the application valve piston and the exhaust valve. It also controls the pedal travel before brake application begins. If stop screw is turned down too far, it will prevent the piston from leaving the exhaust valve and brakes will not release. If it does not open far enough it can result in slow brake release. If stop screw is not turned down far enough, excessive pedal travel will be required to start the brake application, and full application may not be obtained. Adjust stop screw as follows:

1. Loosen lock nut on pedal stop screw.
2. Back stop screw out until there is free play between the push rod and the application valve piston cup.
3. Turn stop screw down until all free play is removed; then back screw out ½ turn and lock.
4. Hold stop screw while tightening lock nut.



1 Treadle Cover
2 Treadle Fulcrum Pin
3 Treadle Fulcrum Pin Roll Pin
4 Access Hole to Mounting Bolt
5 Mounting Plate to Application Valve Bolt
6 Mounting Plate to Cab Floor Bolt and Nut
7 Application Valve
8 Cutout in Cab Floor for Application Valve
9 Mounting Plate to Application Valve Bolt
10 Cab Floor
11 Mounting Plate
12 Mounting Plate to Cab Floor Bolt and Nut
13 Boot
14 Plunger
15 Treadle Roller Pin

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Figure 5—Brake Application Valve Installation

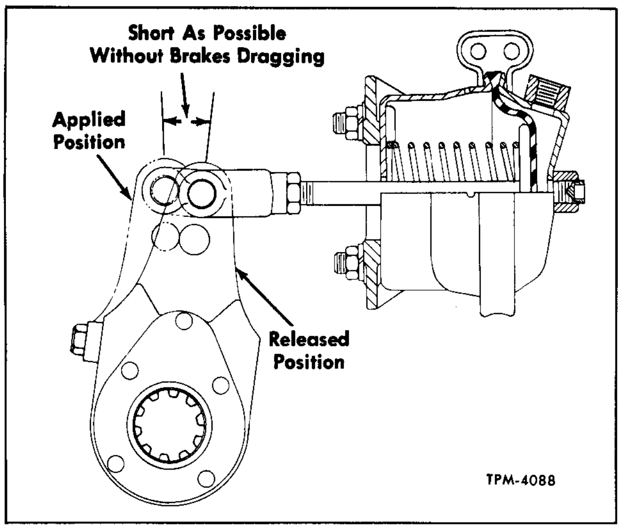


Figure 6—Typical Air Brake Adjustment

5. Check brake operation for full application and release.

TREADLE ADJUSTMENT

Check for free travel between end of push rod and piston cup. If necessary, remove treadle pin, then remove treadle stop bumper and add shims under bumper as necessary to remove clearance between push rod and piston cup. Install treadle pin and secure with cotter pin. Install the complete assembly on toeboard and attach with three bolts, lock washers, and nuts.

BRAKE TREADLE ADJUSTMENT

The treadle used on Alum. Tilt vehicles is NOT adjustable for treadle height or free travel. Refer to figure 5 for illustration of treadle and valve installed.

BRAKE LINING WEAR ADJUSTMENT (Fig. 6)

NOTE: On vehicles equipped with "Stopmaster" brakes, brake shoe adjustment is covered under "Stopmaster Brakes" near end of this section.

Slack adjusters function as adjustable levers and provide a quick and easy method of adjusting the brakes to compensate for normal lining wear. Positive-locking type slack adjusters are used on all vehicles. Internal construction of all slack adjusters is as shown in figure 7, however, lever arm (body) may be offset to suit installation requirements. Refer to "Air Brake Specifications" at end of this section to determine slack adjuster type used.

The most efficient brake action with "S" cam brakes, will be obtained when the arm travel of the slack adjuster is held to a minimum so that

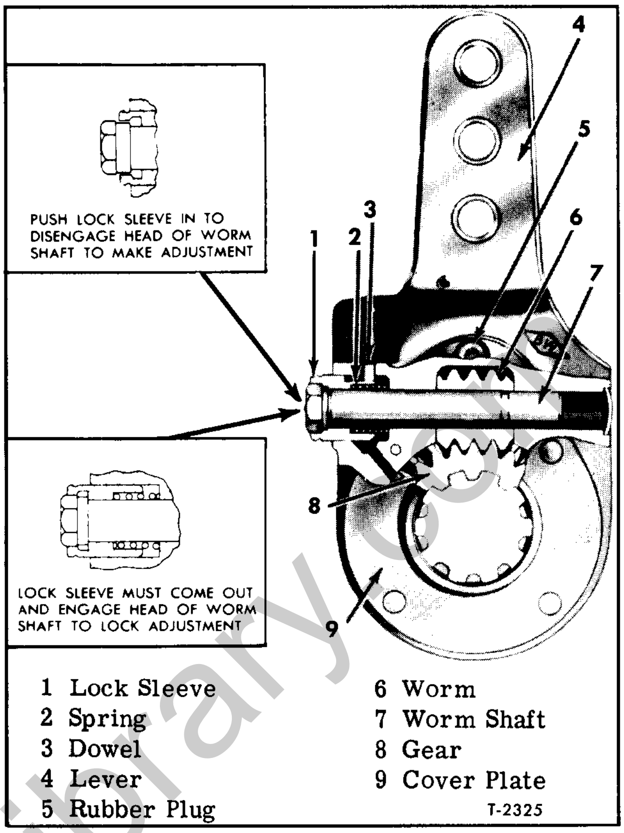


Figure 7—Slack Adjuster

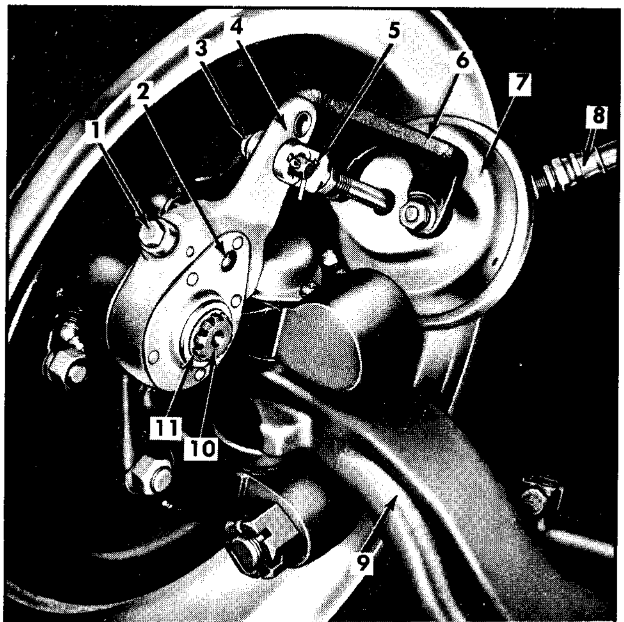
the full length of the lever is utilized during brake application. Minor adjustment to compensate for normal lining wear should be confined to the slack adjusters.

Push rod travel should be maintained as short as possible without brakes dragging (refer to fig. 6). Push rod travel should be checked after every 2,000 miles of operation to determine whether adjustment is necessary. Brake linings should be replaced before wear exposes rivet heads and causes drum damage.

1. With wheel jacked up, turn slack adjuster worm shaft until brake drags, then back off until wheel turns freely.

NOTE: Lock sleeve must be pushed in before worm shaft can be turned (fig. 7). Make sure sleeve is pushed in far enough to clear hex end of worm shaft before turning shaft.

2. Be sure wheel turns freely with brakes fully released. After completing adjustment, make sure lock sleeve comes out and engages hex end of worm shaft (fig. 7). Pry sleeve out with screwdriver if necessary. Coat lock sleeve and end of worm shaft with wheel bearing grease to keep out dirt and moisture to assure free movement of sleeve at next adjustment.



1 Adjusting Worm Shaft	7 Brake Chamber
2 Lubrication Hole Plug	8 Air Brake Hose
3 Clevis Pin	9 Front Axle
4 Slack Adjuster	10 Brake Camshaft
5 Adjusting Clevis	11 Snap Ring
6 Mounting Bracket	T-2197

Figure 8—Brake Chamber and Slack Adjuster Installed (Front)

SLACK ADJUSTERS

SLACK ADJUSTER OPERATING TEST

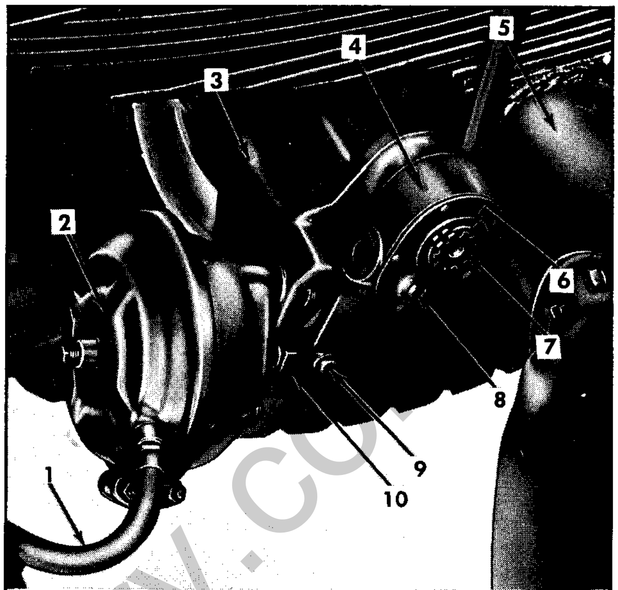
Apply brakes and make sure all slack adjusters rotate freely and without binding. Release brakes and make sure all slack adjusters return to released position freely without binding.

With brakes released, make sure the angle formed by slack adjuster arm and brake chamber push rod is greater than 90 degrees. All slack adjusters should be set at the same angle. With brakes applied, make sure the angle formed by the slack adjuster arm and brake chamber push rod is still slightly greater than 90 degrees and that all are at the same angle. If angle is less than 90 degrees with brakes applied, slack adjuster is going "over center." Adjust brakes as previously described under "Brake Adjustments."

SLACK ADJUSTER REPLACEMENT
(Refer to Figs. 8 and 9)

Removal

1. Remove clevis pin attaching brake chamber push rod yoke to slack adjuster.
2. Remove lock ring or cotter pin and spacer securing slack adjuster on camshaft. Slide slack adjuster off end of shaft.



1 Air Brake Hose	6 Snap Ring
2 Brake Chamber	7 Brake Camshaft
3 Mounting Bracket	8 Lubrication Hole Plug
4 Slack Adjuster	9 Clevis pin
5 Rear Axle	10 Adjusting Clevis T-2196

Figure 9—Brake Chamber and Slack Adjuster Installed (Rear)

Installation

1. If a new slack adjuster is being installed, make sure it is the same size and type as that removed. Make sure spacing washer is in place on camshaft. Slide slack adjuster onto camshaft and attach with spacer and lock ring or cotter pin.
2. Connect brake chamber push rod yoke to slack adjuster with clevis pin and cotter pin. Refer to "Brake Chamber Installation" for adjustment of brake chamber push rod.
3. Adjust brakes as directed under "Brake Adjustments."

BRAKE CHAMBERS (STANDARD)

All service information in the following paragraphs refers only to standard chambers used with cam-type brakes. Chambers used with Stopmaster brakes are covered under the separate heading of "Stopmaster Brakes." There are also two types of "Fail-Safe" chambers covered under their respective headings of "Standard Fail-Safe" and "Super Fail-Safe." A fourth type brake chamber (optional equipment) is covered under the heading of "Brake Chamber (Anchorlok)."

An air brake chamber is used at each wheel to convert the energy of compressed air into the mechanical force and motion required to apply the brakes. The yoke on the brake chamber push rod connects to a slack adjuster which is mounted on

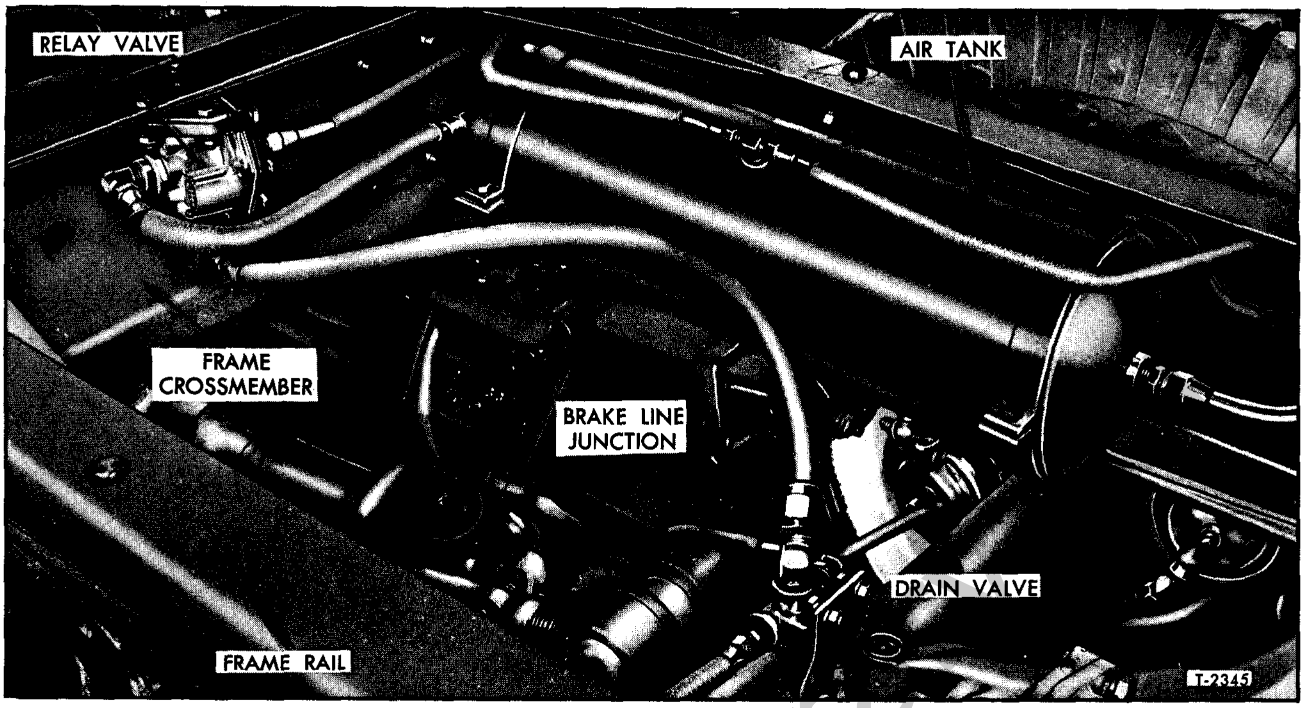


Figure 10—Relay Valve and Air Tank Installed (Typical)

the brake camshaft. Push rod opening and four equally spaced holes near clamping flange in non-pressure plate provide for breathing and drainage. For illustration of brake chambers installed see figure 8 (at front axle) and figure 9 (at rear axle).

Brake chambers have two different type clamp rings; (1) a two-piece ring with two bolts and (2) a one-piece clamp ring with two bolts at the clamp ring joint.

BRAKE CHAMBER OPERATION

As air pressure enters the brake chamber behind the diaphragm, the diaphragm forces push rod outward, thus applying force to the slack adjuster which rotates brake camshaft, applying brakes. When air pressure is released from the brake chamber, the brake shoe return springs and the push rod spring return brake shoes, camshaft, slack adjuster, push rod, and diaphragm to released position.

BRAKE CHAMBER SERVICEABILITY TESTS

1. Operating Test

Apply brakes and see that the brake chamber push rods move out promptly without binding. Release brakes and see that they return to released position without binding.

2. Leakage Test

a. While full brake pressure is being delivered apply soap suds to clamp ring holding the diaphragm in place between pressure plate and non-pressure plate. No leakage is permissible. If leakage is evident, tighten clamp ring bolts.

b. With brakes fully applied, check for leakage through the diaphragm by coating the push rod hole and drain holes in non-pressure plate with soap suds. No leakage is permissible. If leakage is evident, replace the diaphragm.

BRAKE CHAMBER REPLACEMENT

1. Removal

Disconnect air line from brake chamber. Disconnect push rod yoke from slack adjuster. Remove nuts from brake chamber mounting studs, then remove brake chamber assembly.

2. Installation

Install brake chamber on mounting bracket and secure with stud nuts and lock washers. Connect push rod yoke to slack adjuster. Adjust brakes as previously directed under "Brake Adjustment." Apply brakes and make sure push rod is correct length. Angle formed by push rod and slack adjuster should be greater than 90 degrees with brakes released, and with brakes applied after being adjusted, this angle should still be greater than 90 degrees; in other words, the slack adjuster should not go "over center" during brake application. If necessary, adjust yoke on push rod to obtain this condition. Push rod must not extend through yoke far enough to interfere with slack adjuster. Test as directed under "Serviceability Tests."

MAINTENANCE

It is recommended that all brake chambers be removed, disassembled, inspected and thoroughly cleaned at the time that brakes are relined or at one year periods, whichever occurs first (also dependent upon type of operation and operator experience). Any parts worn, cracked, or deteriorated should be replaced.

AIR TANKS

The number of air tanks used and their mounting locations vary from model to model. (Refer to figure 10 for typical installation.) On steel tilt cab models one tank is mounted crossways between frame side rails behind front bumper and in front of first frame crossmember. On conventional 70 models the tanks are mounted under the cab in the left step area, and on conventional 90 models tank is mounted on the left frame rail. Standard air tank on conventional models is a divided tank which incorporates a wet tank and a dry tank in the same assembly, divided by a check valve which is built into the tank.

Most. Alum. Tilt models have three air tanks. The main tank is a divided tank and is mounted below the left frame rail, behind the fuel tank. The parking brake tank is mounted just ahead of the main tank behind the battery tray. An auxiliary tank is mounted inside the right frame rail, directly above the rear axle.

The purpose of the air tanks is to provide a place to store compressed air so there will always be an ample supply available for immediate operation of the brakes. Tanks provide storage for sufficient compressed air for several brake applications with engine stopped.

Another purpose of the air tanks is to provide a place where the air, heated during compression, can cool and the water vapor can condense. Most of this condensation takes place in the "wet" tank; this is the tank into which the compressed air is first discharged from the compressor. Condensation should be drained from all air tanks daily. To drain tanks properly, leave drain cocks open until all air escapes and draining stops. Daily draining is not necessary on those models which have the optional moisture ejector valve.

All pressure for operation of the brakes and air compressor governor is taken from the dry tank. A one-way check valve at inlet to second tank prevents loss of air pressure from the second tank in the event of leakage in the first tank or air compressor discharge line. On tandem axle models, a third air tank or a larger tank is used to provide sufficient volume of air for the additional brake chambers. All air lines are interconnected in a manner similar to the single axle models.

Air tank U-bolts and support bracket to frame bolts should be checked for looseness at regular intervals and tightened if necessary. Air tank may be cleaned inside using steam or hot water. If corrosion or other damage has weakened the tank, it must be replaced.

AIR TANK CHECK VALVE

One-way check valve is installed at inlet to second air tank on steel tilt cab models and to parking brake tank on Alum. Tilt models. Check valve prevents loss of air pressure from second air tank in the event of leakage in the first tank or in the air compressor discharge line. Arrow on valve body indicates direction of air flow through valve.

Check valve should be removed, disassembled, and cleaned at regular intervals. The rubber valve seat should be replaced if there is any evidence of deterioration or hardening. Valve spring should be replaced if weakened by rust or corrosion. Valve disc should be perfectly smooth and free of rust or corrosion. When installing check valve, make sure it is installed to permit air flow from first tank into second tank as indicated by the arrow on valve body.

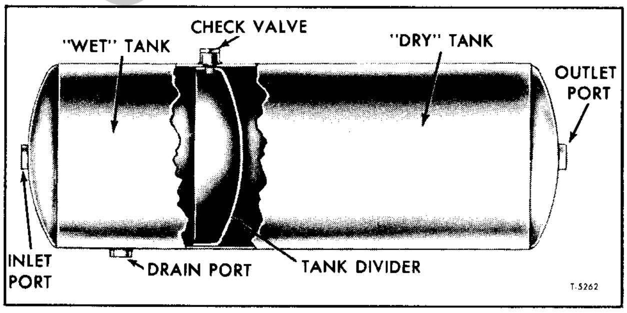


Figure 11—Divided Air Tank

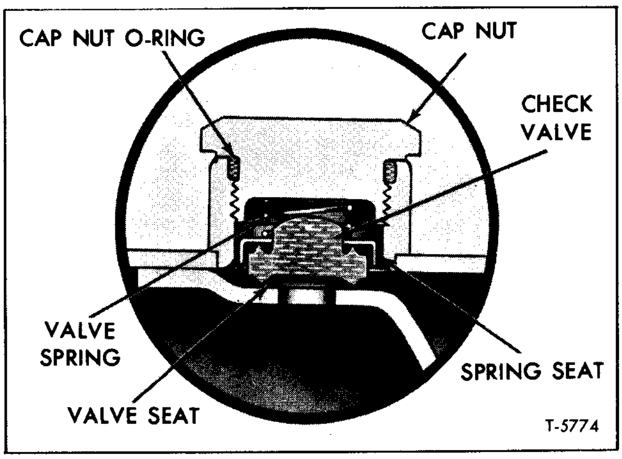


Figure 12—Air Tank Check Valve

On conventional models and Series 9502 models the check valve is built into the air tank at the point where the tank is divided (see fig. 11). This type check valve is a spring-loaded valve and functions the same as the other one-way check valve. The valve is accessible by removing the valve cap from the air tank. Use caution when removing cap as valve is spring-loaded. Replace any parts which appear corroded or deteriorated.

DIVIDED TANK CHECK VALVE SERVICE
(Refer to Fig. 12)

1. Drain air from all reservoirs.
2. Remove cap nut carefully. Nut compresses valve spring and parts will "fly off" if not removed carefully.
3. Remove spring, spring seat, and valve.
4. Inspect all parts for cracking, deterioration, or swollen condition. Discard any bad parts.
5. Clean valve seat area.
6. Reassemble, using new parts as necessary. Install valve, spring seat, and spring.
7. Compress spring by pushing down on cap nut and thread cap nut into tank. Tighten cap nut.
8. Build up air pressure in system and determine effectiveness of check valve by opening drain cock on "wet" portion of tank and note pressure retention in "dry" portion of tank.

SAFETY VALVE

A safety valve is installed in air tank to eliminate the possibility of air pressure building up in the system beyond a safe maximum in the event of failure of the air compressor governor.

OPERATION

When pressure in air tank is built up to exceed 145 to 155 psi, air pressure forces ball valve off seat, permitting air pressure to escape through exhaust port to atmosphere. After pressure bleeds down, spring forces ball back onto seat.

MAINTENANCE

Check safety valve periodically for leakage, using soap suds at exhaust port, with 90 pounds pressure in tank. Leakage should not exceed a 3-inch bubble in 3 seconds. Once a year, safety valve should be disassembled, cleaned with kerosene, and reset to blow off at 145 to 155 pounds pressure.

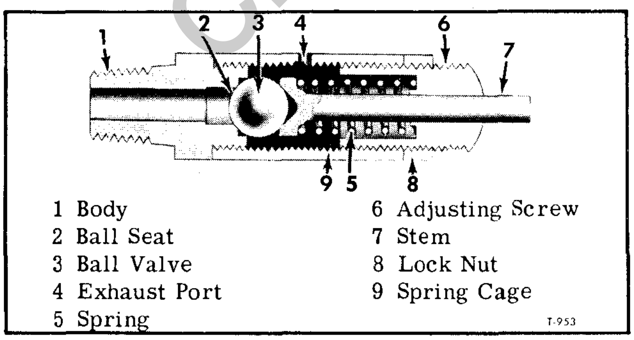


Figure 13—Safety Valve

ADJUSTMENT (Fig. 13)

1. Loosen lock nut.
2. Adjust pressure by turning adjusting screw. Turn clockwise to increase pressure or counterclockwise to decrease pressure.
3. Tighten lock nut.

RELAY VALVE

Relay valve (fig. 10) is used at rear brakes on all tandem axle models. Rear brake application and release is made through the relay valve. The supply line from the air tank connects to the cavity in the lower part of the valve, providing a source of high pressure air close to the rear brake chambers at all times. The relay valve and brake application valve are interconnected by a smaller air line which delivers air pressure to the top of the relay valve diaphragm or piston to actuate the valve. In addition to providing more rapid application of the rear brakes, the relay valve also fulfulls the function of a quick release valve, permitting rapid release of air pressure from the rear brake chambers.

The piston type valve is used on conventional models and Alum. Tilt models and the diaphragm type is used on steel tilt cab models and R7500 models. The principle of operation of both valves is the same. Tests procedures and replacement procedures also apply to both type valves.

RELAY VALVE SERVICEABILITY TESTS

1. Operating Test

With air system fully charged, apply brakes and make sure rear brakes apply promptly. Release brakes and make sure pressure is quickly exhausted from the exhaust port of the relay valve. If exhaust is slow, clean exhaust port filter and strainer plates.

2. Leakage Tests

a. With brakes released, cover exhaust port with soap suds and check for leaks. Leakage is caused by supply valve not seating properly.

b. With brakes applied, cover exhaust port with soap suds and check for leaks. Leakage is caused by defective diaphragm, piston O-ring, or seat.

c. If leakage is excessive, remove relay valve and repair or replace with new valve.

RELAY VALVE REPLACEMENT
(Refer to Fig. 10)

Removal

Exhaust air pressure from air system. Disconnect all air lines from valve. Remove mounting bolts, then remove valve assembly from vehicle.

Installation

Mount valve on crossmember or bracket and tighten mounting bolts firmly. Connect air lines to valve, referring to "Air Lines" section for torque specifications for air line fittings. Build up air pressure in system, then test valve as directed under "Serviceability Tests."

PRESSURE PROTECTION VALVE

The pressure protection valve is used as standard equipment on all conventional cab models in the 70 Series and on all Alum. tilt models, it is mounted in a delivery port of the application valve on 70 Models and in the junction plate on the floor of the cab tunnel on Alum. tilt models. On other Series trucks it may be used with optional equipment (air shift, differential lock, etc.). In the optional application, it is located in the outlet air line of air tank between air tank and optional equipment.

The function of the valve is to close the air lines to horns, wipers, transmission shift, differential lock, etc., when the pressure in the main air system falls below 65 psi (± 5 lbs.). Thus, in the event of pressure loss to 65 psi, there still will be sufficient pressure left to apply service or emergency brakes and stop the vehicle.

REPLACEMENT

Removal

1. Block vehicle wheels.
2. Exhaust air pressure from system.
3. Disconnect air lines to valve.
4. Remove valve from port of application valve (or air tank line).

Installation

1. Install valve in delivery port of application valve (or air tank line).
2. Connect air lines to valve.
3. Build up air pressure in system and check for leaks.
4. Drain air pressure in system below 65 psi and check to determine if valve has shut off supply to applicable units.

QUICK RELEASE VALVE

Quick release valve is used as standard equipment at both front and rear brakes on some models, and at front brakes only on other models. The purpose of the quick release valve is to reduce the time required to release the brakes by hastening the exhaust of air pressure from the brake chambers. The valve consists of a body cover and diaphragm so arranged as to permit air pressure to flow through the valve in one direction. When application pressure is reduced, the air pressure which has passed through the valve is permitted to escape through the exhaust port.

SERVICEABILITY TESTS

1. Operating Test

Apply brakes and observe that when brakes are released, air pressure is exhausted freely through the exhaust port of the valve. Be sure the exhaust port is not restricted in any way.

2. Leakage Test

With brakes applied, coat the exhaust port with soap suds to check leakage. Leakage is caused either by dirt on exhaust seat, by a worn diaphragm, or by a damaged exhaust seat on valve cover.

QUICK RELEASE VALVE REPLACEMENT

Removal

Disconnect air lines from valve. Remove two bolts attaching valve to crossmember or axle bracket and remove valve assembly.

Installation

Mount valve on crossmember or axle bracket and tighten mounting bolts firmly. Connect air lines to valve, referring to "Air Lines" section for torque specifications for air line fittings. Build up air pressure in system, then test valve as directed under "Serviceability Tests."

MOISTURE EJECTOR VALVE

DESCRIPTION AND OPERATION

The moisture ejector valve is mounted on a bracket attached to the cab step support close to the wet air tank on Conventional Models. On Alum. Tilt Models, the moisture ejector valve is mounted on a bracket on the frame crossmember ahead of and above the main air tank. Moisture is ejected each time the brakes are released. Air pressure lifts actuator which lifts plunger, moving inlet valve off seat. This permits flow of air from wet tank into column section of valve. When brakes are released, air pressure snaps actuator back in place, allowing air and moisture in column to escape past plunger seat through exhaust port of lower body to atmosphere. Spring then returns inlet seat and plunger seat to "OFF" position. This action takes place each time brakes are applied and released, thereby operating a

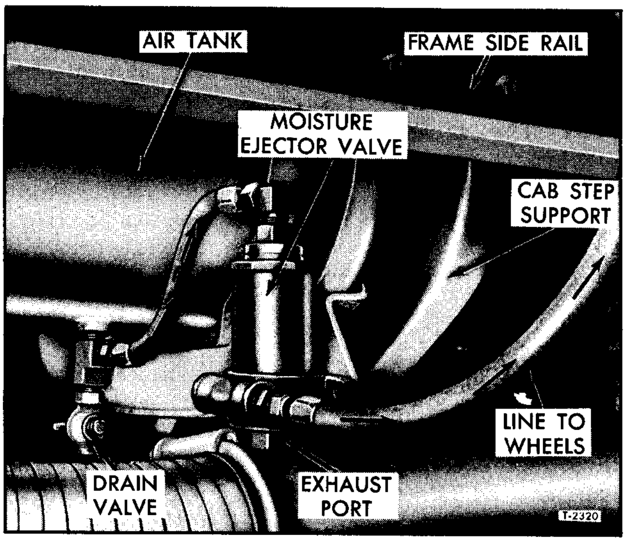


Figure 14—Moisture Ejector Valve Installed (Typical)

continuous process of moisture ejection from brake air system.

The moisture ejector valve is NOT standard equipment. It is offered as optional equipment only on all models.

REPLACEMENT (Refer to Fig. 14)

Removal

1. Exhaust air from system.
2. Disconnect air lines at valve.
3. Remove bolts which fasten valve to bracket on cab step support and remove valve.

Installation

1. Position valve on bracket on cab step support and secure with attaching bolts.
2. Connect air lines at valve.
3. Build up air pressure in system. Check operation of valve while applying and releasing brakes. Check for leaks.

BRAKE APPLICATION VALVES

GENERAL

The brake application valves used on models covered by this manual all operate on the same basic principle. The physical shape of the valves and the methods of mounting differ according to model. There are three mounting types; steel tilt cab models, Alum. tilt models, and conventional cab models.

CONVENTIONAL CAB MODELS

The application valve on these models is fastened to the cowl (fig. 2). The application valve has two studs as part of the assembly and one threaded bolt hole. The application valve is mounted inside the cab and studs extend through holes in cowl. Nuts and lock washers are installed on studs on engine compartment side along with one bolt to fasten application valve securely to cowl. A pedal bracket and pedal assembly is fastened to the bottom of the application valve by three bolts. Pedal assembly contacts application valve piston with an upward movement. The exhaust port is on the back side of the application valve and exhaust air escapes into the engine compartment.

STEEL TILT CAB MODELS

The application valve is mounted on a support bracket in an inverted position inside the cab. The actuating push rod from the brake pedal extends up through the bracket into the valve piston cup as shown in figure 3. A breather tube is installed in the exhaust opening in place of filter screens and a hose connected to the tube carries the exhaust air down below the cab floor.

ALUM. TILT MODELS

On these models, application valve is mounted below cab floor in an upright position. The valve is attached to a mounting plate which is bolted to top side of cab floor. The brake treadle is attached to the mounting plate also, and the push rod extends down through the floor into the valve piston cup. Refer to figure 5.

APPLICATION VALVE REPLACEMENT

On all conventional cab models except MH and MI 90, both Midland-Ross and Bendix-Westinghouse application valves are interchangeable as complete assemblies (including pedal). The component parts are not interchangeable. All valve ports, mounting holes and brackets are located in the same relative places to permit replacement of assemblies regardless of manufacturer. The following procedures covering removal and installation, apply to both Bendix-Westinghouse and Midland-Ross valves.

CONVENTIONAL CAB MODELS (Fig. 2)

Removal

1. To remove pedal only, remove cotter pin and drive out pedal to bracket pin.
2. To remove pedal and valve as an assembly block vehicle wheels or hold by some means other than air brakes.
3. Drain air pressure from brake system.
4. Disconnect air lines from valve both in cab and in engine compartment.
5. From engine side of cowl, remove one bolt and two stud nuts which fasten valve to cowl.
6. Remove pedal and valve assembly from inside cab.

Installation

1. Place pedal and valve assembly in position on cowl inside cab.
2. From engine compartment side of cowl, install one bolt and two stud nuts to fasten valve to cowl.
3. Connect air lines to valve, both in cab and in engine compartment.
4. Start engine and build up air pressure to operating level.
5. Check for leaks.
6. Test operation of brakes.

NOTE: Various items of special or optional equipment are often assembled in outlet ports of the valve, such as low air pressure switch, double check valve, stop light switch, etc. These items may be removed separately from the valve by disconnecting proper air lines, without the necessity of removing the valve from the vehicle. They may also be taken out with the valve as an assembly, if desired.

STEEL TILT CAB MODELS (Fig. 3)

Removal

1. To remove pedal only, remove cotter pin and drive out pedal to bracket pin.
2. To remove pedal, valve, and bracket as an assembly or valve only, block vehicle wheels or hold by some means other than air brakes.
3. Drain air pressure from brake system.
4. Disconnect air lines from valve.
5. Disconnect exhaust hose from valve exhaust port.
6. Remove bolts which attach support bracket to cab and remove complete assembly or·
7. If valve only is to be removed, remove bolts which attach valve to support bracket and remove valve.

Installation

1. To install valve only, place valve in position on support bracket and attach with bolts or:
2. To install pedal, valve and support bracket as an assembly, position in cab and attach assembly to cab with bolts.
3. Connect exhaust hose to valve exhaust port.
4. Connect air lines to valve.
5. Start engine and build up air pressure in brake system.
6. Check for leaks.
7. Test operation of brakes.

NOTE: See Note for "Conventional Cab Models."

ALUM. TILT MODELS

Removal

1. To remove treadle only, remove roll pin from treadle fulcrum pin.
2. Drive out fulcrum pin and remove treadle.
3. To remove treadle, valve, and mounting plate as an assembly, block vehicle wheels or hold by some means other than air brakes.
4. Drain air pressure from brake system.
5. Tilt cab forward and remove splash shield from underside of left front corner to gain access to valve and lines.
6. Disconnect air lines from valve.
7. Remove three nuts from mounting bolts which fasten mounting plate and valve to cab floor. Remove treadle, valve, and mounting plate, as an assembly, from inside cab.

Installation

1. If only treadle has been removed, place treadle in position on mounting plate and drive in fulcrum pin. Install roll pin in treadle and fulcrum pin.

2. To install treadle, valve, and mounting plate as an assembly, set in position on cab floor and install three mounting plate bolts and nuts (loosely).
3. Tilt cab forward and connect air lines.
4. Return cab to normal operating position and tighten mounting bolts and nuts.
5. Start engine and build up air pressure in brake system.
6. Check for leaks.
7. Test operation of brakes.

8. Tilt cab forward and install splash shield on underside of left front corner of cab. Return cab to normal operating position.

NOTE: Various items of standard, special, or optional equipment are often installed in outlet ports of the valve, such as low air pressure switch, double check valve, stop light switch, etc. These items may be removed separately from the valve by disconnecting proper air lines, without the necessity of removing the valve from the vehicle. They may also be taken out WITH the valve as an assembly, if desired.

APPLICATION VALVE SERVICEABILITY TESTS

OPERATION TESTS

Check the delivery pressure of the brake valve using an accurate test gauge connected into one of the air lines leading to the brake chambers. Depress the treadle or pedal to several positions between the fully released and fully applied positions and check the delivered pressure on the test gauge to see that it varies proportionately with the movement of the treadle. When the treadle is fully applied, the reading on the test gauge should be approximately that of full reservoir pressure. The reading on the test gauge should fall off to zero when application is released. Also, check pressures registered on the dash gauge. These should agree with test gauge readings within 5 pounds.

LEAKAGE TESTS

With the valve fully released, check the exhaust port or end of exhaust tube for leakage. No leakage is permissible. Leakage evidenced by this test is probably caused by worn or deteriorated inlet valve seal or by binding or corrosion between the exhaust valve disc and the valve cage, preventing the inlet valve from fully closing.

Make and hold a high pressure application. Coat the exhaust port and the top of the valve with soap suds. No leakage is permissible.

Leakage evidenced by these tests may be due to worn or deteriorated exhaust valve or leaking piston seals.

PREVENTIVE MAINTENANCE

BRAKE PEDAL

No regular, periodic maintenance is required. At the time of each chassis lubrication it is well to check pedal operation.

1. Steel Tilt Cab Models. If the pedal does not move "free and easy," lubricate the pedal to bracket pin and the push rod to pedal pin with engine oil. Use oil sparingly. Do not drip oil on pedal pad.

2. Conventional Cab Models. Some models have pedals with roller contact, others do not. In either case lubricate hinge pin and roller pin (where used) with engine oil. Use oil sparingly.

3. Alum. Tilt Models. Lubricate fulcrum pin and roller pin with engine oil. Use oil sparingly.

BRAKE APPLICATION VALVE

It is recommended that every year, or after 50,000 miles, whichever occurs first (and also dependent upon type of operation and operator experience) that the application valve be removed from the vehicle, disassembled and various components inspected for wear or deterioration. Install new parts where they are found to be worn or damaged. This applies to all valves on all models.

AIR LINES

Metal tubing and flexible hose are used to connect the various units in the air brake system. Service instructions for both types follow:

METAL TUBING

Metal lines are of annealed copper tubing with three-piece compression type fittings. Flared type fittings should never be used in air brake systems. Connections should be tested at least every 5,000 miles and tightened or replaced if necessary. When replacing metal tubing, tubing must be free of burrs, copper cuttings, and dirt. Blow tubing out with compressed air. Any of the above mentioned particles will destroy sealing seats in air control units. New tubing must be of the same size as the old tubing.

Always use a new sleeve when replacing tubing. When tightening tube connector nuts, tighten to torque listed below to assure an air-tight connection. Overtightening will cause leakage. Apply S.A.E. #10 lube oil to ball sleeves, tubes, and male

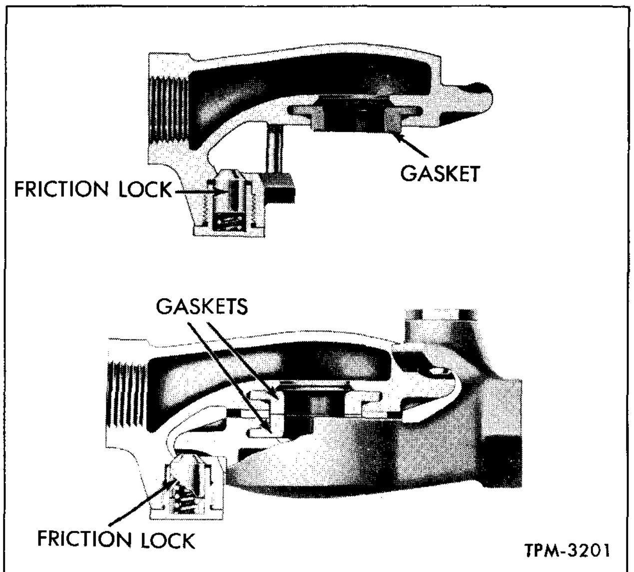


Figure 15—Trailer Hose Coupling

threads, then torque to minimum value and check for leaks. If leaking, back off tube nut approximately ½-turn and retorque to higher than minimum value.

Tubing Size	Torque Inch-Pounds
1/4 Inch	30 to 50
3/8 Inch	30 to 50
1/2 Inch	90 to 115
5/8 Inch	100 to 125

FLEXIBLE HOSE

Flexible hose is used at each brake chamber, between cab and frame, and at trailer connections where it is impossible to use metal tubing due to constant flexing during vehicle operation. Hose connections should be tested at least every 5,000 miles and tightened or replaced if necessary. Any hose which is chafed, worn, or kinked should be replaced.

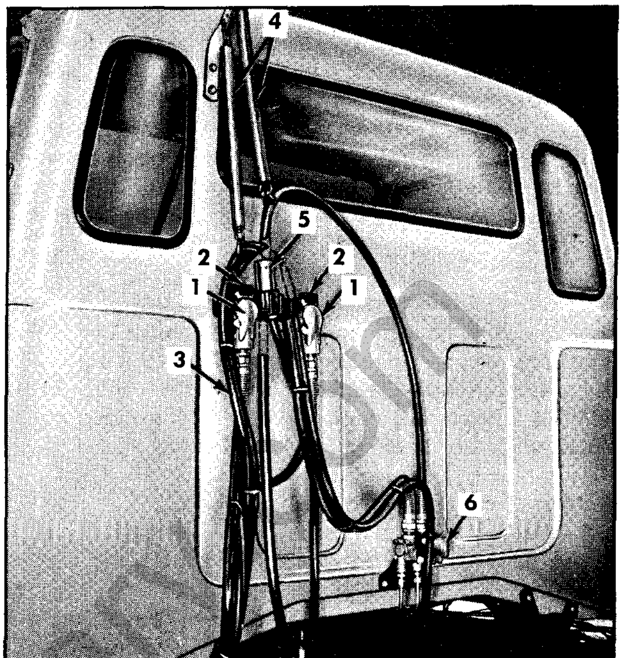
SERVICEABILITY TESTS

1. Operating Test

If any trouble symptoms, such as slow brake application or release, indicates a restricted or clogged air line, disconnect the suspected tube or hose at both ends and blow through it to make sure the passage is clear. Inspect tubing and hose for partial restriction such as would be caused by dents or kinks. If such condition is found, tubing or hose should be replaced.

2. Leakage Test

With air system fully charged and brake applied, coat all tubing and hose connections with soap suds to check for leakage. No leakage is permissible. Leakage is sometimes corrected by tightening the connection. If this fails to correct leakage, new fittings, metal tubing, or flexible hose must be installed.



1 Trailer Hose Couplings
2 Dummy Couplings
3 Brake and Electrical Lines
4 Hose Support Springs
5 Electrical Connections
6 Tractor Protection Valve

T-2346

Figure 16—Trailer Brake Connections (Conv. Model Shown)

TRAILER CONNECTIONS

On vehicles equipped with trailer connections, two air lines are used to connect the truck brake system to the trailer brake system. One of these lines is the "Service" line and the other is the "Emergency" line. The emergency line delivers constant air pressure to the trailer air tank and operating valve, while the service line delivers air pressure to trailer brakes only while the trailer brakes are being operated, either by means of the foot brake system or by the trailer brake hand control valve. Flexible hoses are used to make the connection between the truck and the trailer. Each hose is equipped with couplings for convenience in connecting and disconnecting the truck and trailer brake systems (see fig. 15).

The emergency line is at the right side and is tagged "Emergency." The service line is at the left side and is tagged "Service." When coupling tractor and trailer make sure that air lines are properly connected. Couplings on trailer are also tagged "Service" and "Emergency." See figure 16 for illustration of trailer connections mounted on the back of a conventional cab model.

1. Couplings

Figure 15 shows a sectional view of a single hose coupling, and a view of the two couplings connected. The design of the coupling is such that when the two are connected together, pressure is placed on two rubber gaskets, making an airtight seal. The rubber gaskets should be replaced every six months, or more often under severe operating conditions.

2. Dummy Couplings

Dummy couplings are mounted on rear of cab and serve as hangers for the trailer hose when they are disconnected from the trailer. Both hoses should always be connected to the dummy couplings when not connected to the trailer.

3. Cut-Out Cocks (When Used)

Cut-out cocks are used in the trailer brake lines on vehicles not equipped with trailer breakaway valve. Purpose of cut-out cocks is to provide a means of closing off these lines when they are not being used. The cut-out cock is open when the handle is at a 90-degree angle to the body, and is closed when the handle is parallel with the body. Stops are provided so the handle cannot be turned beyond its normal open and closed positions.

Cut-out cocks should be tested periodically for leakage. Connect cut-out cock to source of air pressure, build up 90 pounds pressure against it, and cover opening with soap suds. If leakage exceeds a 1-inch bubble in 3 seconds, cock should be repaired or replaced. In some instances, leakage may be caused by dirt on the key. This condition can be remedied by cleaning the key and seat with gasoline, then grinding the key to its seat with grade 400 grinding compound. Thoroughly wash off all grinding compound and coat key lightly with a good grade of cup grease before assembling. If the key or body is badly scored, the complete cut-out cock should be replaced.

AIR PRESSURE GAUGE

The air pressure gauge in the instrument panel provides the driver with a means of checking system air pressure. The vehicle should never be put in motion until pressure reaches 65 pounds. If pressure reading drops to less than 65 pounds while vehicle is in motion, vehicle should be stopped and the cause of air loss corrected. Dash gauge should be checked regularly with an accurate test gauge. If pressure reading varies 4 pounds or more, replace gauge with a recalibrated unit.

LOW AIR PRESSURE SWITCH

Low air pressure switch is used with a buzzer as a low air alarm. Buzzer is also used as a part of engine alarm system. The switch is installed in a delivery port of the application valve or in a fitting which is installed in a delivery port of the application valve on all models except Alum. tilt. On Alum. tilt this switch is installed in a fitting on the junction plate in the floor of the cab tunnel, inside the cab. Switch is adjusted and sealed by the manufacturer and is not reparable. Switch has only one wire terminal, being internally grounded.

The low air pressure switch is an air-controlled switch in an electrical circuit, automatically controlling a buzzer in the cab. A tell-tale light is also used. Refer to appropriate Wiring Diagram in applicable "Wiring Diagrams" for electrical circuits.

The switch has a nominal pressure setting of 58 to 65 psi. If switch fails, it must be replaced. When installing switch, do not use sealing compound on threads, since the switch is grounded through its mounting and sealing compound will act as insulation.

TRAILER BRAKE CONTROLS

INDEPENDENT TRAILER BRAKE APPLICATION

On vehicles equipped with trailer brake hand control valve, trailer brakes may be applied without applying the truck brakes. When hand control valve lever is moved to applying position, air pressure passes through the hand control valve and double check valve into trailer brake service line, applying the trailer brakes. When hand control valve lever is returned to released position, air pressure in the trailer brake service line is exhausted from exhaust port of the control valve, releasing the trailer brakes. Any desired degree of trailer brake application is obtained by regulating the position of the hand control valve lever.

I.C.C. BRAKE SYSTEM EQUIPMENT

Some vehicles are equipped with special I.C.C. (Interstate Commerce Commision) brake system equipment in conjunction with the trailer brake controls. These controls are a tractor protection (breakaway) valve and a trailer emergency air supply control valve. These controls are provided for the following purposes:

1. They protect the tractor air system from complete loss of air pressure in the event of a trailer breakaway or loss of air pressure in the trailer air system.

2. They automatically actuate the trailer brake emergency relay valve (on trailer) in case the tractor air system pressure falls below 45 psi.

3. They provide the driver with a manual means of actuating the trailer brake emergency relay valve (on trailer).

TRAILER BRAKE HAND CONTROL VALVES

Several different trailer brake hand control valves are used on vehicles covered by this manual. On steel tilt and conventional cab models the valve is mounted on the steering column with the operating handle on the right-hand side (see fig. 17). On alum. tilt models the valve is mounted on the console to the right of the steering wheel. Only the operating handle is visible as the valve itself is mounted behind a cover panel on the console.

The valve graduates the delivered air pressure in proportion to the degree the operating handle is moved. That is the farther the handle is moved from "OFF" to "ON," the greater the air pressure delivered to the trailer brakes. If, at any time during such an application, a service brake application is also made with the foot-controlled valve, whichever valve releases the greater air pressure will control the brakes.

On some valves it is necessary to hold the handle in the desired position in order to apply trailer brakes. When handle is released, it automatically returns to the "OFF" position. On others the handle will remain in the placed position until manually moved. Other than this, operation of all valves is identical.

HAND CONTROL VALVE REPLACEMENT (ALL EXCEPT ALUM. TILT)

Removal

1. Block vehicle wheels.
2. Drain air from brake system.
3. Disconnect air lines from valve.
4. Remove bolts attaching mounting bracket and valve to steering column.
5. Remove valve and bracket.

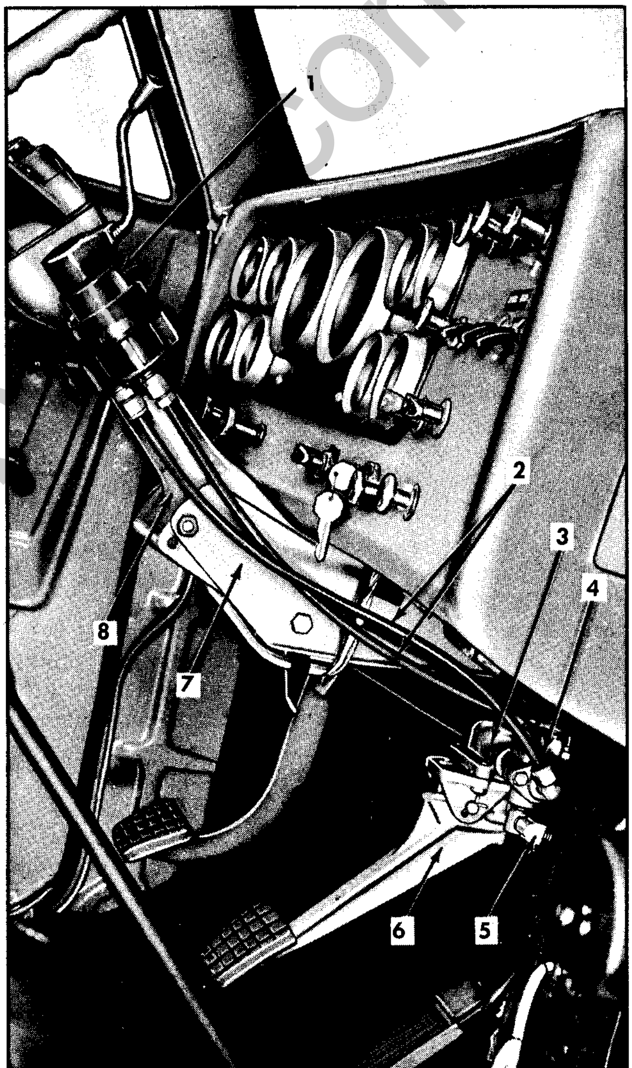
Installation

1. Position valve and mounting bracket on steering column. Fasten with bolts.
2. Connect air lines to valve.
3. Start engine and build up air pressure.
4. Check for leaks and operation of brakes.

HAND CONTROL VALVE REPLACEMENT (ALUM. TILT)

Removal

1. Block vehicle wheels or hold by some means other than air brakes.
2. Drain pressure from air system.
3. Remove large circuit breaker access cover from behind instrument panel.
4. Remove tractor parking-emergency brake valve knob and nut.



1 Trailer Brake Hand Control Valve
2 Air Lines to Application Valve
3 Application Valve
4 Stop Light Switch and Double Check Valve
5 Line to Tractor Protection Valve
6 Brake Pedal
7 Steering Column Bracket
8 Steering Column

T-2195

Figure 17—Trailer Brake Hand Control Valve and Brake Application Valve Installed (Conv. Models)

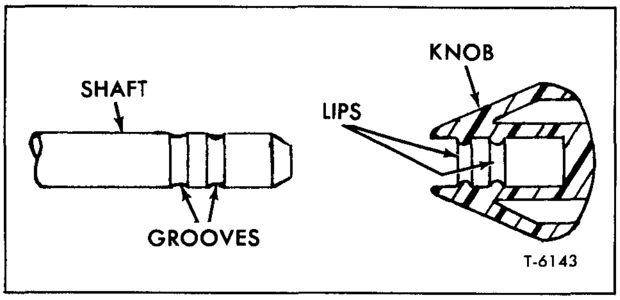


Figure 18—Trailer Brake Valve Knob and Shaft

5. Remove trailer emergency brake valve knob and nut.
6. Remove trailer hand control valve knob.

NOTE: This knob is a pliable plastic knob which is held on shaft by two lips which fit into two grooves on shaft (see fig. 18). Pull straight off. Considerable pull is required to remove knob and it is usually damaged at removal so that it cannot be reused.

7. Remove eight screws which hold cover panel from in front of trailer brake hand control valve, tractor parking-emergency brake valve, and trailer emergency brake valve.
8. Through access behind instrument panel disconnect air lines and remove bolts which fasten trailer brake hand control valve to support bracket. Remove valve through opening made by removal of cover panel.

Installation

1. Install trailer brake hand control valve through opening made by removal of cover panel. Place in position on support bracket and fasten with bolts.
2. Connect air lines through access behind instrument panel.
3. Install valve cover panel over valve shafts and fasten with eight screws.
4. Install trailer brake hand control valve knob. See figure 18 and refer to "Removal" procedure Step 6.
5. Install trailer emergency brake valve nut and knob.
6. Install tractor parking-emergency brake valve nut and knob.
7. Build up air pressure in system and check for leaks.
8. Install circuit breaker access cover behind instrument panel.

TRAILER EMERGENCY AIR SUPPLY CONTROL VALVES

The trailer emergency supply control valve, working in conjunction with the tractor protection (breakaway) valve, controls the operation of the trailer brakes in EMERGENCY situations.

NOTE: THIS SYSTEM IS NOT DESIGNED TO BE USED AS A PARKING BRAKE UNDER ANY CIRCUMSTANCES.

There are several different model control valves used on these vehicles but all operate on the same principle. They are spring-loaded valves which will automatically act when pressure in the truck brake system falls below 45 psi.

Whenever the emergency air valve is actuated, either manually or automatically, truck air system pressure must be built up above 45 psi and valve knob must be manually pushed in to charge the trailer emergency line and release the trailer brakes.

There are two different valves used on conventional cab models, one Bendix-Westinghouse and one Midland-Ross. These two valves are interchangeable on conventional cab models as complete assemblies. However, on any given vehicle, it is necessary to use a breakaway valve of the same manufacturer with each control valve; you can NOT use a B-W control valve with an M-R breakaway valve, and vice versa.

EMERGENCY CONTROL
VALVE REPLACEMENT
(ALL EXCEPT ALUM. TILT)

Removal

1. Drain air pressure from brake system.
2. Disconnect air lines.
3. Steel Tilt Cab - Remove screws from plate which holds valve to bracket at left of steering column. Remove valve.

Conventional Cab - Disconnect knob and push rod assembly from piston stem. Remove screws which fasten valve to cowl. Remove valve from engine compartment side of cowl.

Installation

1. Position valve at mounting bracket (tilt cab) or cowl (conventional) and attach air lines.
2. Secure valve with screws. Install plate where used.
3. On conventional cab models connect knob and push rod to valve stem.
4. Start engine and build up air pressure to operating level.
5. Check for air leaks.
6. Check operation of trailer emergency brake.

EMERGENCY CONTROL VALVE REPLACEMENT (SERIES 9502)

Removal

1. Block vehicle wheels or hold by some method other than air brakes.
2. Drain pressure from air system.
3. Remove knob and nut from valve shaft.
4. Remove circuit breaker access cover from behind instrument panel.
5. Disconnect air lines from valve.
6. Remove valve through opening behind instrument panel.

Installation

1. Place valve in position through opening behind instrument panel.
2. Connect air lines.
3. Push valve shaft up through control panel and install nut and knob on valve shaft.
4. Build up pressure in system and check for leaks.
5. Install access cover behind instrument panel.

SYNCHRO VALVE

The purpose of the synchro valve is to balance application pressures to tractor and trailer brakes under emergency conditions. When the tractor parking-emergency brakes are applied the synchro valve automatically causes the trailer emergency system to apply with the same amount of pressure used in the tractor system. The basic purpose of this type application is to prevent trailer "jack-knife" conditions, which can result from applying only tractor brakes while vehicle is in motion.

The synchro valve is mounted in the console in the supply part of the trailer emergency brake control valve. It is used only on Series 9502 models.

SERVICEABILITY TESTS

1. Operating Test. Pull knob of tractor-emergency brake and note that trailer emergency brakes also apply. Push knob of valve in and note that trailer emergency brakes release.
2. Leakage Test. Using soap suds, check for leakage both with brakes applied and released. If any leakage is evident, remove valve from vehicle and repair or replace.

REPLACEMENT

Removal

1. Block wheels or make parking brake application.
2. Exhaust air from brake system.
3. Remove large circuit breaker access cover from behind instrument panel.
4. Disconnect air lines from valves as necessary.
5. Remove synchro valve from supply port of trailer emergency control valve.

Installation

1. Install synchro valve in supply port of trailer emergency control valve.
2. Connect air lines.
3. Start engine and charge air brake system with full pressure.
4. Check connections for leaks.
5. Test operation of brakes.
6. Install large circuit breaker access cover behind instrument panel.

TRACTOR PROTECTION (BREAKAWAY) VALVE

The tractor protection valve, used in conjunction with the trailer emergency air supply control valve, controls operation of the trailer brakes in EMERGENCY situations.

This valve is located on the inner side of the cab back panel on steel tilt cab models, on underside of cab tunnel on Alum. tilt, and on the outside of the cab back panel on conventional models (see fig. 16).

Both service and emergency trailer brake lines are routed through this valve, and its basic function is to protect the tractor air brake system from loss of pressure in the event of pressure loss in the trailer system.

There are two optional valves used on conventional cab models, one Bendix-Westinghouse and one Midland-Ross. They are interchangeable as complete assemblies but each must be used with a control valve made by the same Manufacturer. You CANNOT use a B-W breakaway valve with an M-R control valve, and vice versa. The Bendix-Westinghouse valve has two mounting bolt holes, while the Midland-Ross valve has three mounting bolt holes.

BREAKAWAY VALVE REPLACEMENT

Removal

1. Block vehicle wheels.
2. Drain air pressure from brake system.
3. Disconnect air lines.
4. Remove mounting bolts and valve.

Installation

1. Position valve on back of cab and install mounting bolts.
2. Connect air lines.

3. Start engine and build up air pressure to operating level.

4. Check for leaks.

5. Check operation of brakes.

SERVICEABILITY TESTS

Operating Tests

1. Pull out emergency air valve knob to exhaust air pressure from breakaway valve control line. Disconnect trailer emergency line from emergency outlet port at breakaway valve and connect an air pressure test gauge to emergency outlet port.

2. Start engine and build up air pressure in system. Low air pressure buzzer should stop operating at 58 to 65 psi. With air pressure in operating range, push emergency air valve knob in. Test gauge should show full air system pressure. Then pull knob out; test gauge should drop to zero.

3. Again build up air pressure in system to operating range, then stop engine. Push emergency air valve knob in. Make a series of brake applications until low air buzzer sounds. Slightly open drain cock in the dry air tank to obtain a slow (approx. 10 psi per minute) pressure drop in the tractor brake system. When truck air system drops to 45 psi (approx.), the emergency air valve knob should automatically come out and pressure on test gauge should rapidly drop to zero.

Leakage Tests

1. Build up air pressure in truck brake system to operating range. Push in emergency air valve knob to charge trailer brake system. Use soap suds to coat exhaust ports of emergency air valve and breakaway valve.

2. When emergency air valve leaks excessively, install new piston O-rings. When breakaway valve leaks excessively, install new O-rings and plunger seal.

TRACTOR PARKING—EMERGENCY BRAKE VALVE

REPLACEMENT (ALUM. TILT)

Removal

1. Block vehicle wheels or hold by some method other than air brakes.

2. Drain pressure from air system.

3. Remove knob and nut from valve shaft.

4. Remove circuit breaker access cover from behind instrument panel.

5. Disconnect air lines from valve.

6. Remove valve through opening behind instrument panel.

Installation

1. Place valve in position through opening behind instrument panel.

2. Connect air lines.

3. Push valve shaft up through control panel and install nut and knob on valve shaft.

4. Build up pressure in system and check for leaks.

5. Install access cover behind instrument panel.

DOUBLE CHECK VALVE AND STOP LIGHT SWITCH

A combination double check valve and stop light switch is used in brake systems equipped with trailer brake controls except Alum. tilt. Check valve is used to connect both the foot brake application valve and the trailer brake hand control valve to the trailer brake service line. Check valve is installed in delivery port in brake application valve. Air line from trailer brake hand control valve connects to other end of check valve. Trailer brake service line and truck stop light switch are connected to the two side outlet ports.

CHECK VALVE OPERATION

When brake application is made by the foot brake valve, air pressure from the foot brake valve forces the shuttle valve over against the inlet from the hand control valve and flows out the holes in the valve guide into the trailer brake service line. When foot brakes are released and trailer brakes are applied by means of the hand control valve, air pressure from the hand control valve forces the shuttle valve over against the inlet from the foot brake valve and flows out through the holes in the valve guide into the trailer brake service line.

CHECK VALVE SERVICEABILITY TESTS

1. Operating Tests

a. Apply truck brakes and note that brakes apply promptly on both the truck and the trailer. Release truck brakes and note that brakes on truck and trailer both release promptly.

b. Move hand control valve lever to applied position and note that brakes apply only on the trailer. Move control valve lever to released position and note that trailer brakes release promptly.

2. Leakage Tests

a. Apply truck brakes and check for leakage at hand control valve exhaust port, using soap suds.

b. Apply trailer brakes only with hand control valve and check for leakage at truck brake application valve exhaust port, using soap suds.

c. No leakage is permissible in either of these tests. If there is any leakage, replace the shuttle valve.

CHECK VALVE REPLACEMENT

Removal

1. Block vehicle wheels.
2. Drain air pressure from brake system.
3. Disconnect air lines from valve.
4. Screw valve out of brake application valve.

Installation

1. Screw valve into brake application valve.
2. Connect air lines.
3. Start engine and build up air pressure to operating level.
4. Check for leaks.
5. Check operation of brakes and stop lights.

EMERGENCY BRAKE STOP LIGHT SWITCHES

Series 9502 vehicles are equipped with a stop light switch in the tractor emergency brake air system. Vehicles with trailer brake equipment also have a stop light switch in the trailer emergency brake air system. Both switches are located in fittings fastened to the junction plate in the floor of the cab tunnel, inside the cab. The purpose of these switches is to light the stop lights to warn following drivers of brake application on truck and/ or trailer.

TESTING OPERATION OF SWITCHES

1. Check all lights to make certain bulbs operate by activating service brakes.
2. Release brakes.
3. Turn engine control switch to "ON" position.
4. Pull tractor parking - emergency brake control knob out. If stop lights do not light, switch is defective.
5. Push tractor parking - emergency brake control knob in and pull trailer emergency brake control knob out. If stop lights do not light, switch is defective.

REPLACEMENT

1. Block vehicle wheels.
2. Exhaust air from brake system (tractor or trailer, or both if both switches are to be replaced).
3. Make sure engine control switch is in "OFF" position or master circuit breaker is open.
4. Disconnect positive battery cable.
5. Remove instrument panel access cover.
6. Disconnect the electrical wires from the switch(es).
7. Remove switch(es) from fittings.
8. Reverse procedure to install new (or repaired) switch(es) and test operation of system(s).

FRONT BRAKE LIMITING VALVE AND TWO-WAY CONTROL VALVE

A combination limiting and quick release valve and a two-way control valve are used in combination on some vehicles as shown in figure 19. This combination permits full brake valve delivery pressure to the front brakes when on dry roads, or at the option of the driver, limits the pressure to the front brakes to 50 per cent of the brake valve delivery pressure when on slippery roads.

The two-way control valve is mounted either on instrument panel or on engine side of fire wall or on the console on Alum. tilt models. The limiting quick release valve is mounted on frame crossmember near the front brake chambers. One air line from brake application valve is connected to the inlet port of the two-way valve and another connects to the brake valve port at top of limiting quick release valve (fig. 19). Another air line connects the side delivery port of the two-way valve to the port opposite the mounting pad of the limiting quick release valve. The two other side ports of the limiting quick release valve are connected to the front brake chambers.

The limiting quick release valve, besides providing for a 50 per cent reduction of front wheel brake pressure, also serves as a quick release valve when brakes are released.

SERVICEABILITY TESTS

1. Operating Tests

a. Connect an air pressure test gauge into the air line leading to the rear brake quick release or relay valve; disconnect air line at valve and connect gauge to line if no other convenient connecting point is available. Disconnect one front brake chamber line from port at side of limiting quick release valve and connect another test gauge to this port.

b. Place the handle of the two-way valve in the "DRY ROAD" position and apply the truck brakes. Both test gauges should read the same. Place the handle of the two-way valve in the "SLIPPERY ROAD" position and apply the truck brakes. The test gauge at the limiting quick release valve should read approximately one-half the amount

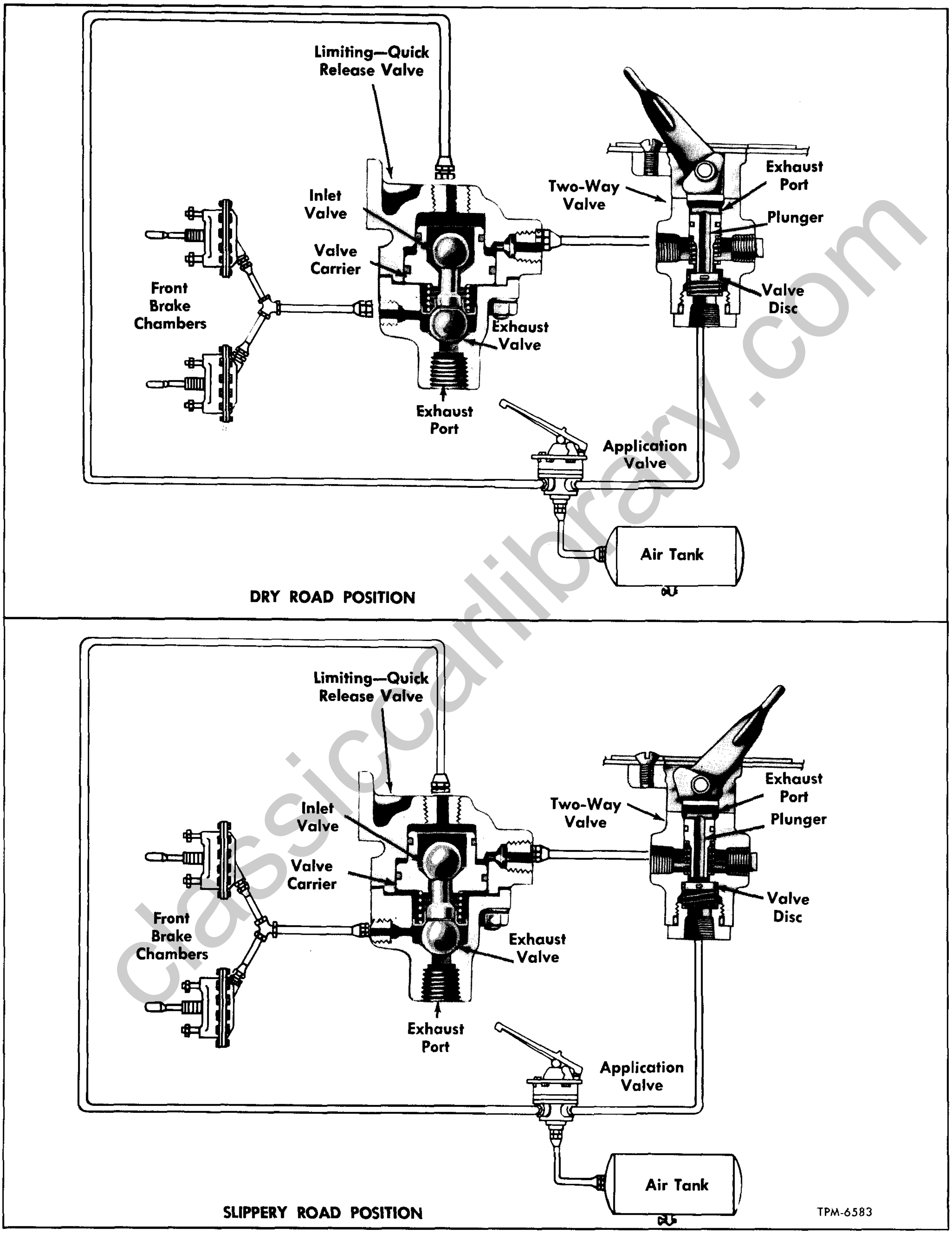


Figure 19—Front Brake Limiting and Two-Way Control Valve Operation

shown on the test gauge connected to the rear axle air line.

2. Leakage Tests

a. Place the handle of the two-way valve in "DRY ROAD" position and with the truck brakes applied, coat the exhaust ports of the two-way valve and limiting quick release valve with soap suds. If leakage is excessive, valve should be replaced or repaired.

b. Place the handle of the two-way valve in the "SLIPPERY ROAD" position and with the truck brakes applied, coat the exhaust port of the two-way valve with soap suds. If leakage is excessive, valve should be replaced or repaired.

TWO-WAY VALVE REPLACEMENT

Removal

1. Block vehicle wheels.
2. Drain air pressure from brake system.
3. Disconnect air lines.
4. Remove screws which fasten plate and valve to instrument panel. Remove plate and valve. For overhaul, refer to "Differential Control Valve" in "REAR AXLE" (SEC. 4A) of this manual.

Installation

1. Position valve in instrument panel and connect air lines.
2. Fasten valve and plate to instrument panel.
3. Start engine and build up air pressure to operating level.
4. Check for leaks. Check operation of brakes.

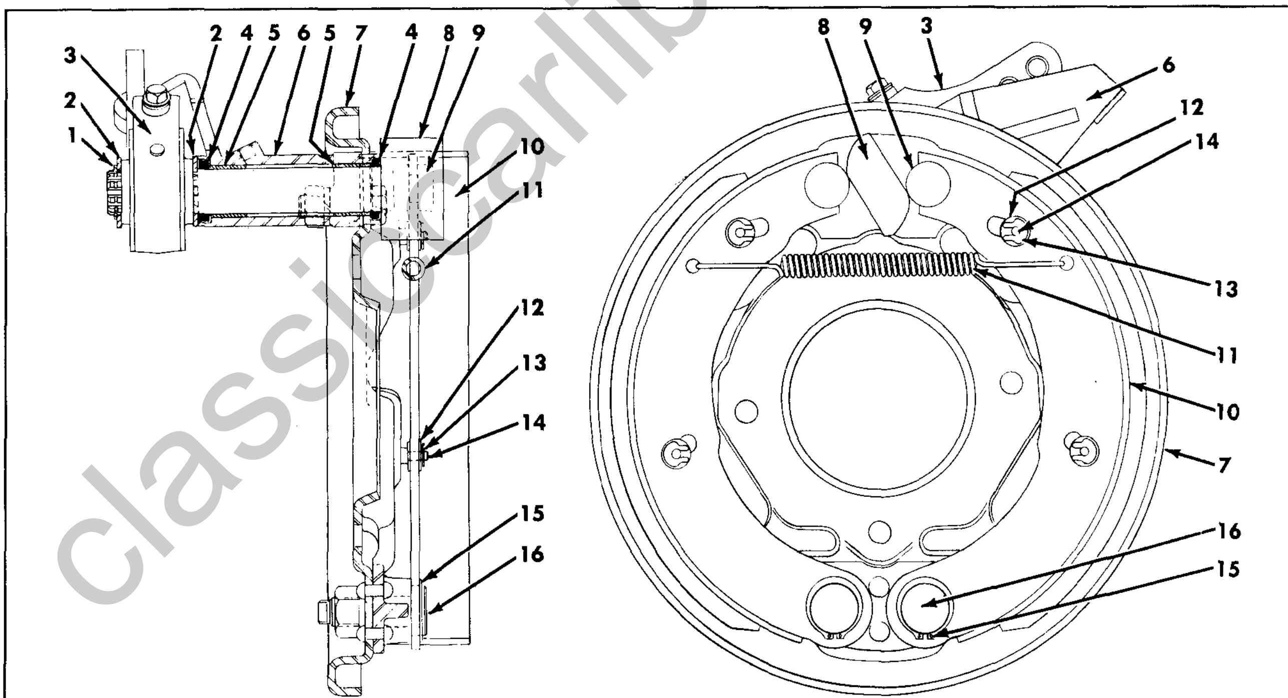
LIMITING VALVE REPLACEMENT

Removal

1. Block vehicle wheels.
2. Drain air from brake system.
3. Disconnect air lines.
4. Remove bolts which fasten valve to vehicle. Remove valve.

Installation

1. Connect air lines.
2. Position valve on vehicle and fasten with bolts.
3. Start engine and build up air pressure to operating level.
4. Check for leaks.
5. Check operation of brakes.



1 Lock Ring
2 Spacer
3 Slack Adjuster
4 Camshaft Seal
5 Camshaft Bushing
6 Camshaft and Brake Chamber Bracket
7 Backing Plate
8 Cam (integral with shaft)
9 Cam Roller
10 Brake Shoe
11 Brake Shoe Return Spring
12 Guide Pin Washer
13 Guide Pin "C" Washer
14 Guide Pin
15 Lock Ring
16 Anchor Pin

T-1584

Figure 20—Front Brake Assembly (Wagner)

FRONT BRAKE SHOES AND ANCHOR PINS

Wagner front brakes are standard on all models. Rockwell front brakes are used on Chevrolet F-160 axle which is used as optional equipment on some models.

WAGNER BRAKES (Fig. 20)

Anchor pin ends of shoes are secured on anchor pins by lock rings. Shoe ends are not equipped with bushings; if shoes or anchor pins become worn, parts must be replaced. Contact between cam ends of shoes and cam is made through rollers. No lubricant should be applied at rollers or cam head; anchor pin ends should be coated with S17 Special Lubricant or equivalent at assembly. Guide pins, two for each shoe, hold shoes in alignment on backing plate.

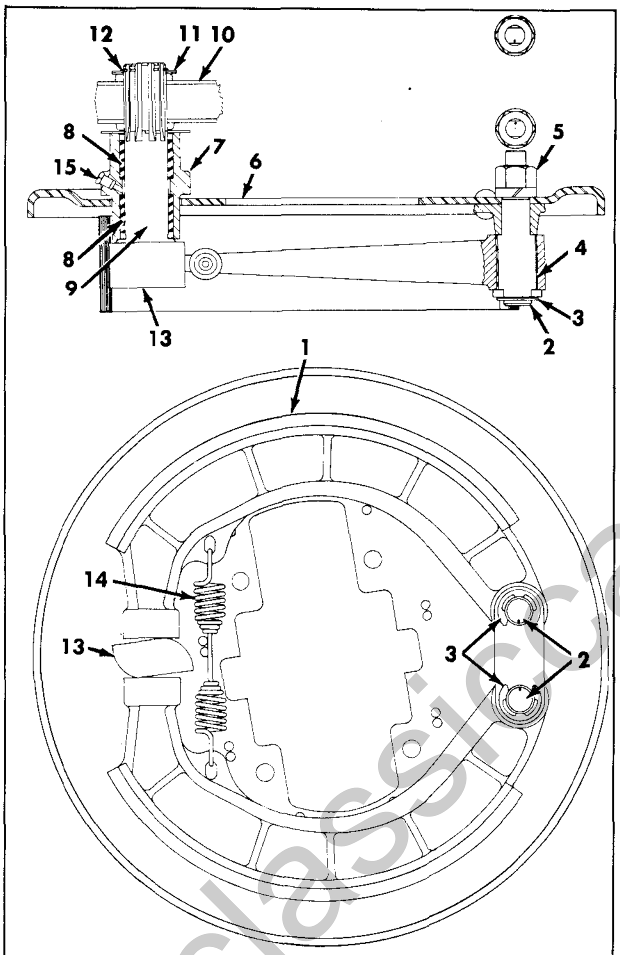
ROCKWELL BRAKES (Fig. 21)

Models equipped with optional F-160 axle (fig. 21). Front brake shoes are retained on adjustable eccentric type anchor pins by C-washers. Anchor pin ends of shoes are equipped with replaceable bushings. Cam end of each shoe is flame-hardened at surface in contact with cam.

ALL MODELS

One-piece molded lining is riveted to each shoe. Lining should be replaced before it becomes worn to the extent that the rivets will damage the brake drum. Make sure new lining fits firmly against shoe and that all rivets are properly upset. When brake drums have been machined oversize, shims should be used between lining and shoe or oversize lining used to maintain proper lining-to-drum contact. Refer to "Brake Drums" in this section. Maximum braking efficiency can be obtained immediately if linings are trued-up with a conventional lining grinder so they are properly centralized in relation to center of hub.

Whenever any part of the brake assembly has been removed and replaced, adjust brakes as directed under "Brake Adjustments."



1 Brake Shoe and Lining Assembly
2 Anchor Pins
3 Anchor Pin C-washers
4 Brake Shoe Bushing
5 Anchor Pin Lock Nut
6 Backing Plate
7 Camshaft Bracket
8 Camshaft Bracket Bushing
9 Camshaft
10 Slack Adjuster
11 Slack Adjuster Spacers
12 Lock Ring
13 Cam (Integral with shaft)
14 Brake Shoe Return Spring
15 Lubrication Fitting

TPM-8228

Figure 21—Front Brake Assembly (Rockwell)

<u>Anchor Pin Adjustment (Fig. 21)</u>
<u>(F-160 Axle Only)</u>

On F-160 axle, whenever brakes have been relined or anchor pin positions changed for any reason, anchor pins must be adjusted to properly locate the curvature of the lining to drum and to obtain proper lining to drum clearance. Make adjustment as follows:

1. Loosen anchor pin lock nuts and turn pins to position punch marks as close together as possible as shown in figure 21.

2. Rotate cam by turning slack adjuster worm shaft to bring shoe lining into contact with the brake drum. Rotate anchor pins just enough to relieve drag. Repeat the adjustment until further rotation of the anchor pins will no longer relieve drag.

3. Tighten anchor pin lock nuts. Back off cam to released position by turning slack adjuster worm shaft. Adjust brake chamber push rod travel as directed under "Brake Adjustments."

FRONT BRAKE CAMSHAFTS

Front brake camshafts have constant lift type cams forged integral with shaft. Camshafts are mounted in camshaft and brake chamber brackets which are bolted to backing plate (figs. 20 and 21). Each bracket is equipped with two bushings and a lubrication fitting. Space between bushings acts as a lubricant reservoir.

CAUTION: DO NOT overlubricate camshaft, as excess lubricant will be forced into brake drums.

Lubricant should be applied sparingly at intervals specified in LUBRICATION (SEC. 0).

Slack adjuster, mounted on splined end of camshaft, is held in place by a lock ring. A spacer is used on each side of slack adjuster. Whenever camshaft has been removed, coat bushing surfaces with S-17 Special Lubricant or equivalent before installing. After installation, apply lubricant as directed in LUBRICATION (SEC. 0), and adjust brake as directed under "Brake Adjustments."

Refer to "FRONT HUBS AND BEARINGS" (SEC. 3D) of this manual for removal of wheels, hubs, and brake drums for access to brake shoes.

"S" CAM REAR BRAKES

Wagner "S" cam brake assemblies are used on rear axle of all steel tilt cab models. All conventional cab models and Alum. Tilt models use "Stopmaster" brakes at rear axle. Brake assembly can be removed as a complete assembly; however, the various components must be replaced individually. Brake assembly shown in figure 22 is a typical Wagner brake assembly.

Brakes are readily accessible by removing wheels, hubs, and drums.

BRAKE SHOES AND ANCHOR PINS
(Refer to Fig. 22)

Refer to "REAR HUBS AND BEARINGS" (SEC. 4C) for removal of wheels, hubs, and brake drums for access to brake shoes.

Each brake shoe consists of a shoe table with two shoe webs welded in place. At anchor end, shoe webs straddle the mounting flange on brake spider and pivot on anchor pins. Anchor pins are held in place by a lock ring at each end. A leather

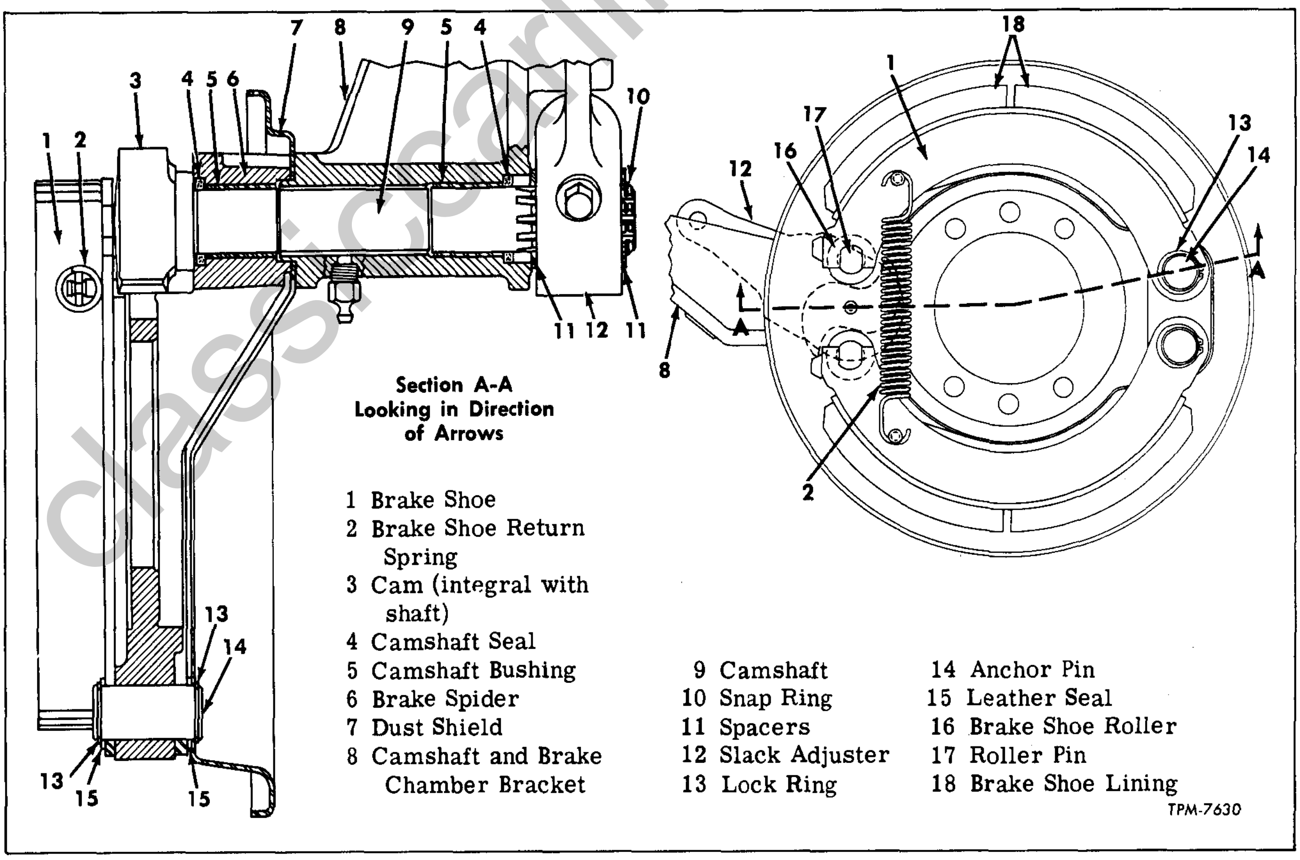
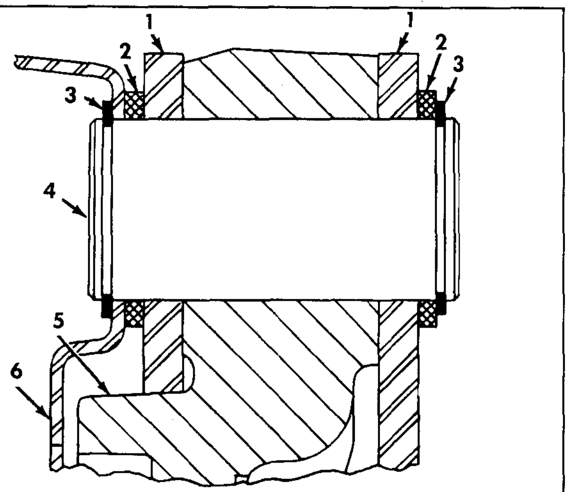


Figure 22—Rear Brake Assembly (Wagner)



1 Brake Shoe
2 Seal
3 Lock Ring
4 Anchor Pin
5 Brake Spider
6 Dust Shield T-2328

Figure 23—Rear Brake Shoe Anchor Pin Installation

seal is used between lock ring and shoe web at outer end and between dust shield and shoe web at inner end to retain lubricant and exclude dirt. Shoe ends are not equipped with bushings; if shoes or anchor pins become worn, parts must be replaced. Refer to figure 23 for cross-sectional view.

At cam end of each shoe, a roller installed between shoe webs on a roller pin makes the contact between shoes and cam. Flats on end of roller pin fit into notches in shoe webs. Tension of brake shoe return spring holds shoe rollers firmly against cam. Return spring pins are staked in 8 places so that they will not slide out of shoe webs. No lubrication is required at rollers or roller pins; parts should be assembled clean and dry. Anchor pin ends should be coated with S-17 Special Lubricant or equivalent during installation.

A two-piece molded lining is riveted to each shoe. Linings should be replaced before wear exposes the rivet heads and causes damage to brake drums. Both linings on each shoe are identical and can be installed at either end. New linings must be securely riveted to shoe with correct size rivets, and rivets must be properly upset. Maximum braking efficiency can be obtained immediately if linings are trued-up with lining grinder so they are properly centralized in relation to center of hub.

Whenever any part of the brake assembly has been removed and replaced, adjust brakes as directed under "Brake Adjustments."

CAMSHAFT AND MOUNTING

Rear brake camshafts have constant lift, S-type cams forged integral with shaft. Camshaft is carried in a bushing in brake spider at outer end, and in a bushing in camshaft and brake chamber bracket at inner end. Camshaft and brake chamber bracket is bolted to brake spider in conjunction with the brake dust shield. Lubrication fitting in bracket provides a means of lubricating both bushings; space between bushings serves as a lubricant reservoir. Seals, in outer end of camshaft bore in brake spider and in inner end of bracket, retain lubricant and exclude dirt. Apply lubricant at intervals indicated in LUBRICATION (SEC. 0) of this manual.

CAUTION: DO NOT overlubricate camshaft, as excess lubricant may be forced by the seals into the brake drums.

Slack adjuster, mounted on splined end of camshaft, is held in place by a lock ring. A spacer is used on each side of slack adjuster. On the brake assembly shown in figure 22, the two spacers (11) are the same; on some models equipped with offset slack adjusters, the inner spacer is thicker than the outer spacer. Whenever camshaft has been removed, coat bushing surfaces with S-17 Special Lubricant or equivalent before installing. After installation, apply lubricant as directed in LUBRICATION (SEC. 0) of this manual, and adjust brakes as directed under "Brake Adjustments."

BRAKE DRUMS

Brake drum installations are illustrated in "REAR HUBS AND BEARINGS" (SEC. 4C) and in "FRONT HUBS AND BEARINGS" (SEC. 3D) in this manual. By referring to the illustrations in the above sections, methods of replacing brake drums are readily discernible.

Whenever brake drums are removed for servicing brakes, inspect drums. If found to be scored, rough, or out-of-round, drums should be machined.

Machining or grinding of brake drums increases the inside diameter of the drum and changes the lining to drum fit. When machining drums, it is recommended that the following maximum oversizes not be exceeded:

(a) Drums with standard diameter up to 14" can be machined up to 0.060" oversize.
(b) Drums with standard diameter over 14" can be machined up to 0.080" oversize.

When it is found that machining to these maximum limits does not provide a suitable braking surface, discard the worn drum and replace with a new standard drum.

DO NOT EXCEED THESE LIMITS. THIS IS A SAFETY PRECAUTION.

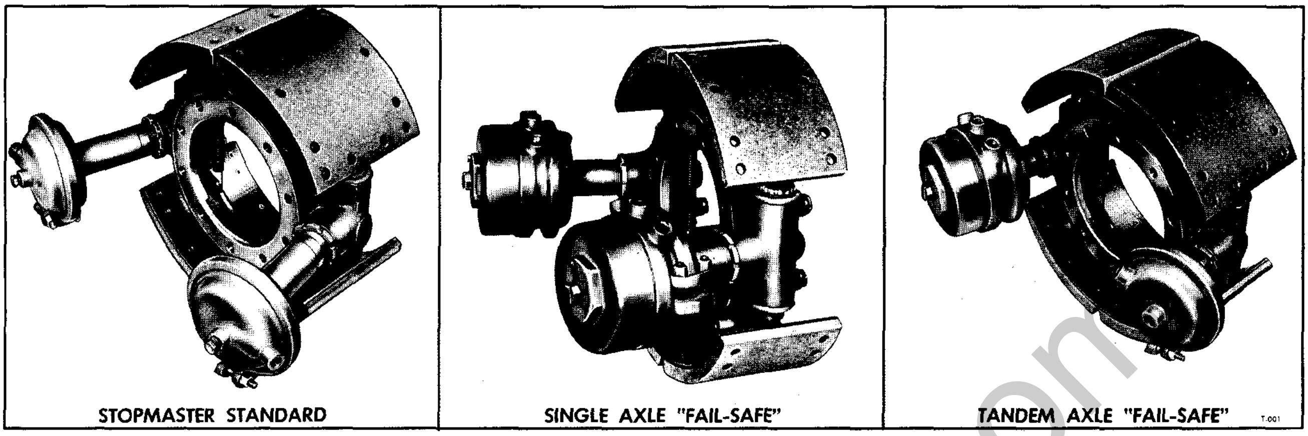


Figure 24—Stopmaster Brake Assemblies

STOPMASTER BRAKES

The Stopmaster type brake differs from the conventional "S" cam type brake in several respects. The air chamber push rod is connected to the brake shoes through a series of wedges, rollers, and plungers rather than through a slack adjuster and camshaft. Stopmaster brakes employ two different type air chambers; (1) a standard air chamber which is operated by air pressure and (2) a "Fail-Safe" air chamber which can be operated either by air pressure or by spring pressure. There are three basic variations of Stopmaster brakes shown in figure 24.

AUTOMATIC ADJUSTER

All Stopmaster brakes have automatic adjuster mechanisms. The basic part of the adjuster (refer to fig. 25) is a plunger assembly which is made up of the adjusting plunger, the actuator, and the adjusting bolt. The actuator is threaded internally to receive adjusting bolt. On the external surface, there are buttress type teeth. The plunger guide is free to slide in a drilled hole in the spider housing and has teeth to match those on the exterior surface of the actuator. A spring, gasket, and bolt are used to hold the guide in contact with the actuator.

Figure 26 is an illustration of an automatic adjuster assembly installed. When the plunger assembly is moved outward to apply the shoe against the drum, the plunger guide will slide across the sloping sides of the teeth on the actuator. If the plunger assembly moves outward and exceeds the pitch distance, the teeth on the guide will engage the next teeth on the actuator. When the plunger returns, the actuator must rotate in order to allow the assembly to return to the "in" position. This rotation is caused by the angle of the teeth. As the actuator rotates, it screws the adjusting bolt. The distance for the plunger to move before adjusting is controlled either by the angle of the teeth, and/ or the number of teeth. This travel establishes the lining-drum clearance.

The plunger guide has two flat sides, which are a slip fit in a slot in the adjusting plunger. This performs two functions: (1) it prevents the guide from turning, and (2) it prevents the adjusting plunger from turning in the housing.

In order to function properly the adjusting bolt must not turn. If it rotates with the actuator, no adjustment would occur.

The combination of the number of teeth on the outside of the actuator and the number of threads per inch on the adjusting bolt establishes the actual linear advance or rate of adjustment.

Procedures covering the removal and installation of automatic adjuster components are given in the following paragraphs:

Any time the adjuster assemblies are removed for service they should be lubricated as directed in the following procedures:

The adjuster system should be disassembled

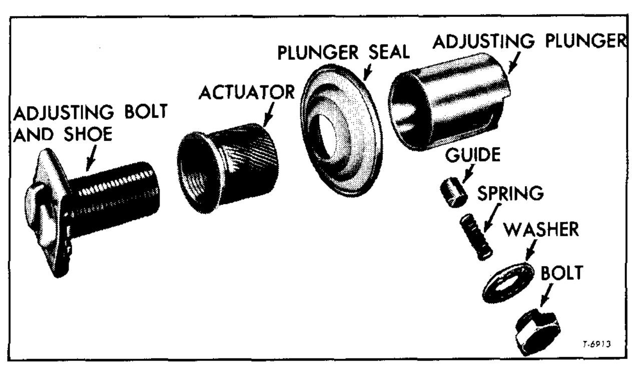
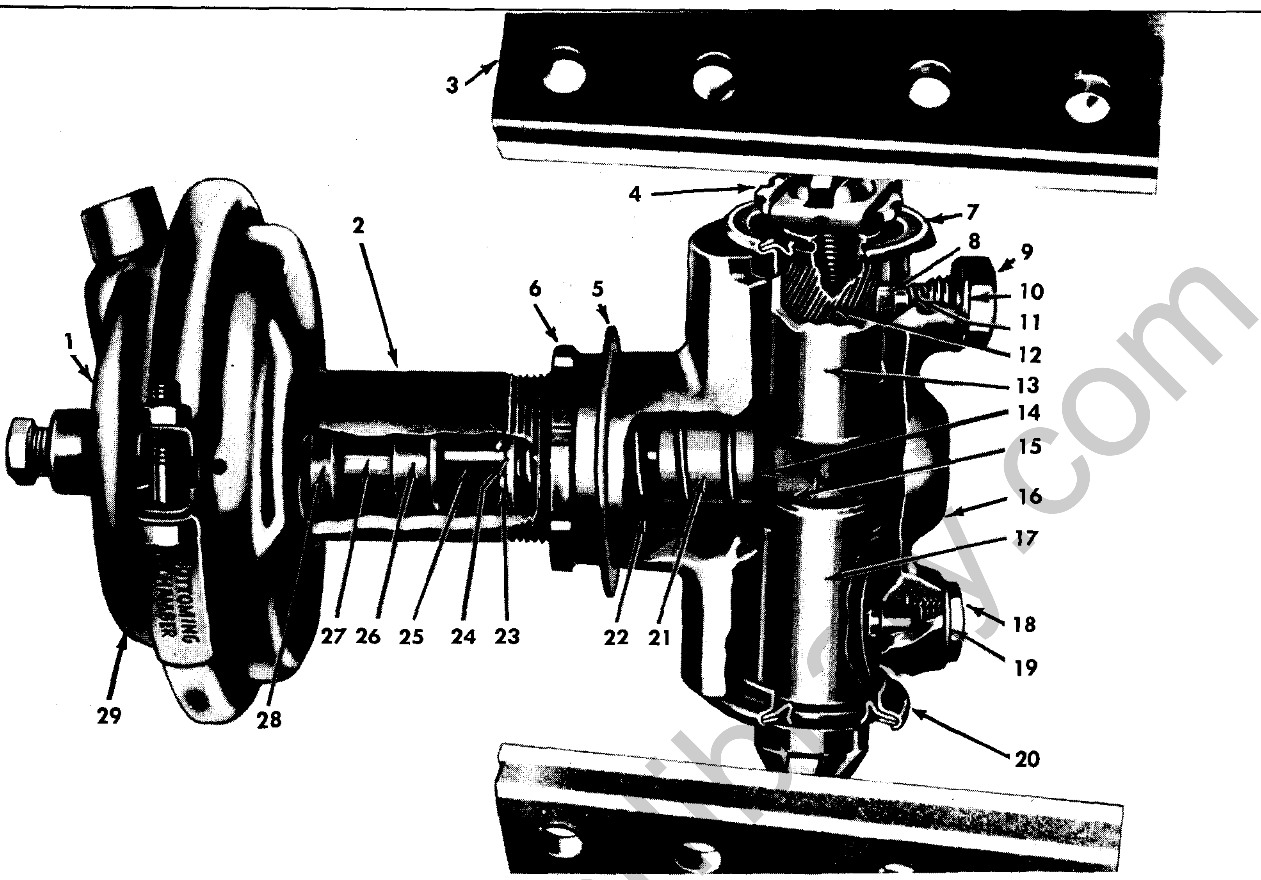


Figure 25—Automatic Adjuster Components



1 Brake Air Chamber Assy.
2 Non-Pressure Half
3 Brake Shoe Assembly
4 Adjusting Bolt Assy.
5 Identification Ring
6 Collet Nut
7 Plunger Seal and Retainer
8 Adjusting Pawl (Plunger Guide)
9 Hollow Cap Screw
10 Gasket
11 Spring
12 Adjusting Sleeve (Actuator)
13 Adjusting Plunger
14 Wedge Spring Retainer
15 Roller
16 Plunger Housing
17 Anchor Plunger (Solid)
18 Guide Screw
19 Gasket
20 Plunger Seal and Retainer
21 Roller Retaining Cage
22 Wedge Spring
23 Cotter Key
24 Washer
25 Wedge Shaft
26 Wedge Guide
27 Diaphragm Plate (Push Rod)
28 Rubber Boot
29 Pressure Half

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Figure 26—Automatic Adjuster Assembled

whenever brake shoes are relined and inspected for the general condition of all moving parts. It is advisable to use new plunger seals and gaskets when removing and installing these parts.

REMOVAL (Refer to Fig. 25)

1. Remove brake shoes and brake chambers as detailed under applicable procedures.
2. Remove bolt and plunger guide gasket from housing.
3. Remove spring and plunger guide.
4. Unscrew adjusting bolt from actuator.
5. Using a screwdriver, pry plunger seal out of spider housing.
6. Remove actuator and adjusting plunger.

INSTALLATION (Refer to Fig. 25)

NOTE: Make sure that adjusting mechanism is installed at proper end of spider so that brake shoe ends are mounted in proper position. Also make certain that all parts are properly lubricated. All threads on all components should be coated with lubricant to assure smooth, free operation. The tip of the plunger guide and the entire plunger should also be coated. See LUBRICATION (SEC. 0) in this manual under symbol "S28" for type of lubricant to be used.

1. Install new seal on adjusting plunger and actuator.
2. Install adjusting plunger and actuator in spider housing.

3. Tap plunger seal into place in spider housing (see fig. 33).

4. Screw adjusting bolt into actuator to the full length of threads, then back off ¼ turn so that screw will not jam and fail to adjust when assembly is complete (see fig. 27).

5. Install plunger guide in spider housing. The end of the guide with teeth is installed first and the flat sides of the guide must fit into the slot in the adjusting plunger to mesh with the outer teeth of the actuator.

> **CAUTION: The chamfered notch on the back end of the guide must be toward the plunger seal end of the housing, otherwise the automatic adjustment feature will not function. When properly assembled, if adjusting bolt is turned in one direction, the brake will adjust and if turned in opposite direction a ratcheting effect will result, regardless of which direction adjusting bolt is turned.**

6. Install spring, gasket and bolt.

7. Install anchor plunger components as described under "Brake Actuation Components."

8. Install brake shoes and brake chamber as detailed under applicable procedures.

INITIAL ADJUSTMENT

If a new installation has just been made as described above, start engine and build up required amount of air pressure in system. Then pump the brake pedal until the automatic adjuster system adjusts enough to provide sufficient brake for safe driving. Final adjustment is made with the vehicle in motion, by pumping the pedal.

SERVICING STANDARD STOPMASTER BRAKE CHAMBERS

It is recommended that all brake chambers be removed, disassembled, inspected, and thoroughly cleaned at the time that brakes are relined or at one year periods, whichever occurs first (also dependent upon type of operation and operator experience). Thorough cleaning, proper lubrication and replacement of any worn parts on a preventive maintenance basis will assure proper operation of the system at all times.

Instructions covering the removal and service of standard chambers follows (refer to fig. 28):

REMOVAL AND DISASSEMBLY

1. Disconnect air lines from chambers.

Figure 27—Installing Adjusting Bolt

2. Using a spanner wrench or a punch and hammer, loosen collet nut which secures air chamber to brake spider housing.

3. Remove air chamber assembly from brake spider housing.

4. Remove bolt and nut which secure clamping ring.

5. Scribe a mark across the pressure housing and the non-pressure housing to assure proper reassembly.

6. Remove diaphragm, rod, boot, and guide from housings.

CLEANING AND INSPECTION

1. Clean all metal parts thoroughly, using a suitable cleaning fluid. Blow dry with air or wipe dry with cloth. (Do not use solvent on diaphragm.)

2. Examine diaphragm and replace with new part if any signs of wear or deterioration are evident.

3. Inspect pressure housing for scratches, scores, or excessive wear. Examine all parts for obstructions and remove any foreign matter.

4. Examine diaphragm plate rod boot for deterioration or cracks. If deterioration or other damage is evident, replace. In order to replace

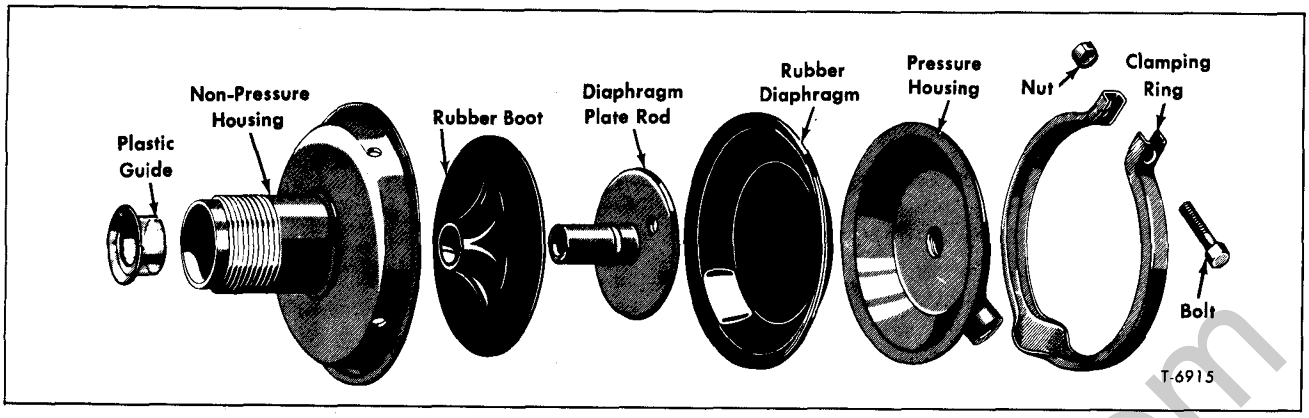


Figure 28—Standard Stopmaster Air Chamber Components

boot it is necessary to remove the plastic guide from the end of the rod. If the guide is damaged or worn, it too should be replaced. Apply a liberal amount of rubber cement to boot flange and mating surface on non-pressure housing.

BRAKE CHAMBER ASSEMBLY AND INSTALLATION

1. Install boot, rod, guide, and diaphragm in non-pressure housing.
2. Position pressure housing on non-pressure housing so that scribe marks made at disassembly are aligned.
3. Install clamping ring on assembly and secure with bolt and nut.
4. Install air chamber in brake spider housing until it "bottoms" in spider. Then back off not more than one full turn to position chamber ports in line with air tubes. The plastic guide will assure proper positioning of the wedge. At this point lock the air chamber in position by tightening the collet nut against lock washer and the spider housing (see fig. 29). Drive collet nut tight with a drift and hammer.

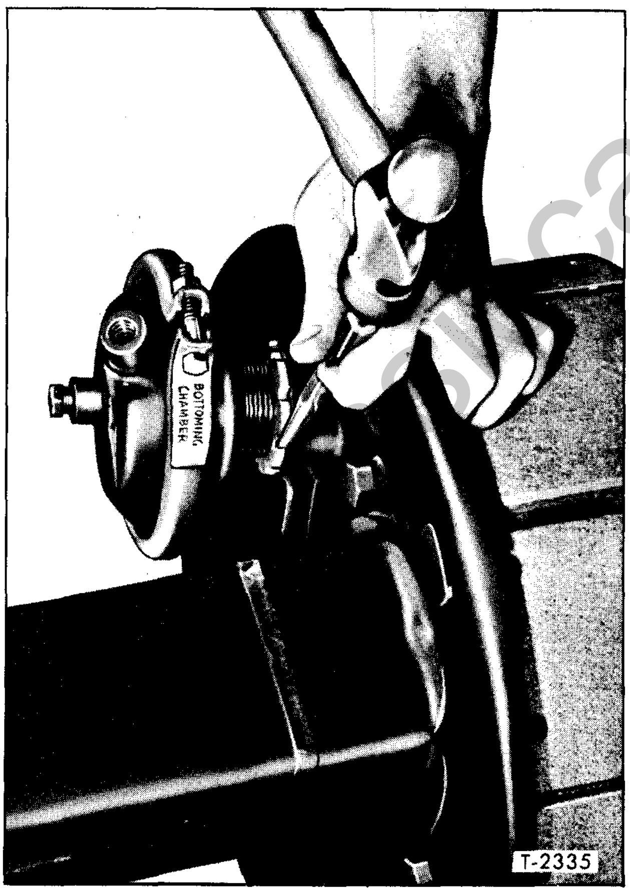


Figure 26—Tightening Collet Nut

BRAKE SHOES AND LININGS

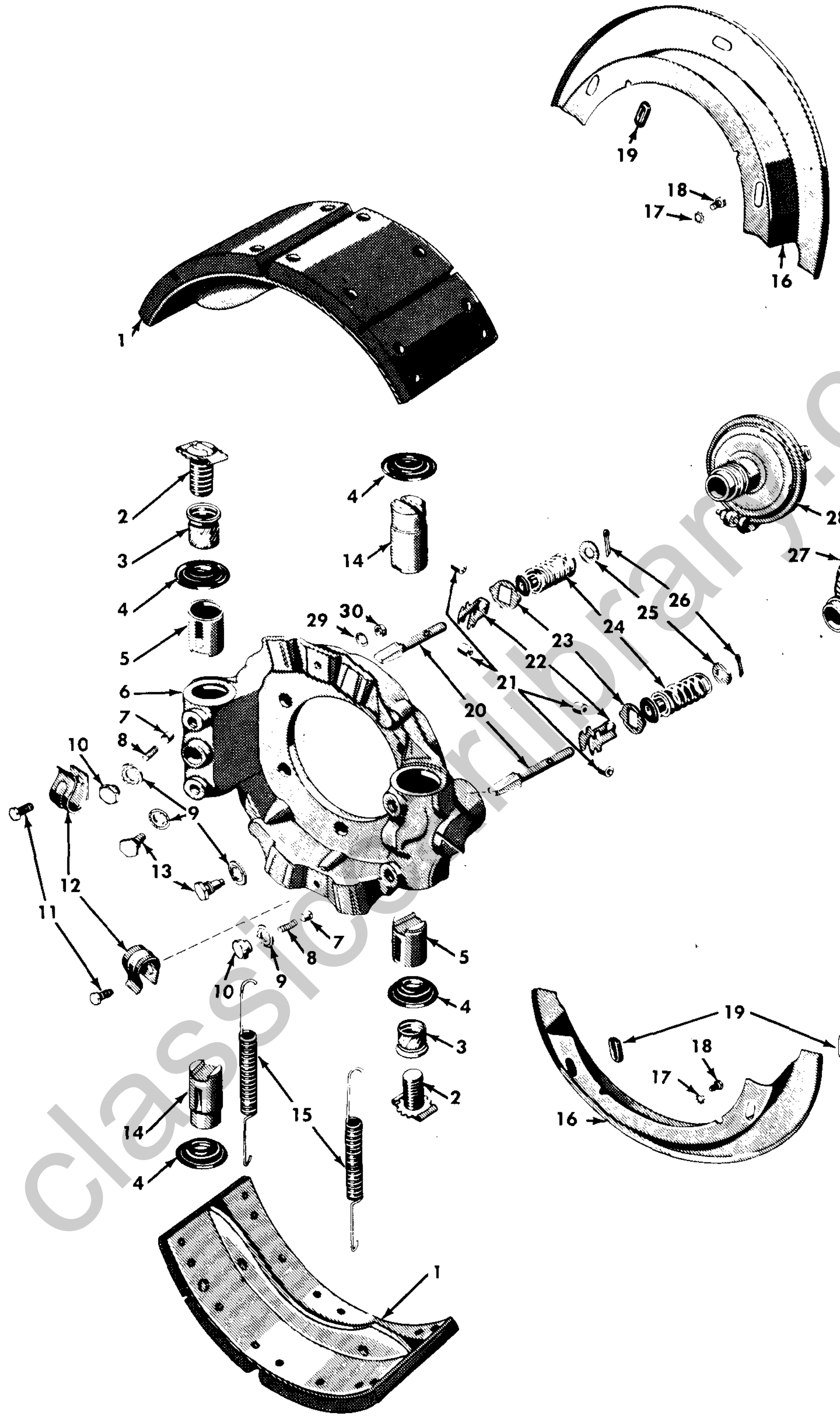
BRAKE SHOE REMOVAL
(Refer to Fig. 30)

1. Jack up rear of vehicle and remove wheels.
2. Remove hub and brake drum assembly. Refer to "REAR SUSPENSION" under "HUBS AND BEARINGS" (SEC. 4C) of this manual.
3. Remove brake shoe return springs from both shoes.
4. Lift brake shoe web out of shoe hold-down clip and out of notches in anchor and adjusting plungers.

NOTE: Mark adjusting end of brake shoes to ensure correct reassembly.

SHOE RELINING

Each brake shoe consists of a shoe table with a single web welded in place. A two-piece molded lining is riveted to each shoe. Lining should be replaced before wear exposes the rivet heads and causes damage to brake drums. Both linings on each shoe are identical and can be installed at either end. New linings must be securely riveted to shoe with correct size rivets, and rivets must



1 Brake Shoe and Lining Assembly
2 Adjusting Bolt Assy.
3 Adjusting Sleeve (Actuator)
4 Plunger Seal and Retainer
5 Adjusting Plunger
6 Brake Spider (Plunger Housing)
7 Adjusting Pawl (Plunger Guide)
8 Spring
9 Gasket
10 Hollow Cap Screw
11 Bolt
12 Brake Shoe Hold-Down Clip
13 Guide Screw
14 Anchor Plunger (Solid)
15 Brake Shoe Return Spring
16 Dust Shield
17 Lock Washer
18 Bolt
19 Dust Cover
20 Wedge Shaft
21 Roller
22 Roller Retaining Cage
23 Wedge Spring Retainer
24 Wedge Spring
25 Washer
26 Cotter Pin
27 "Failsafe" Air Chamber
28 Standard Air Chamber
29 Lock Washer
30 Nut

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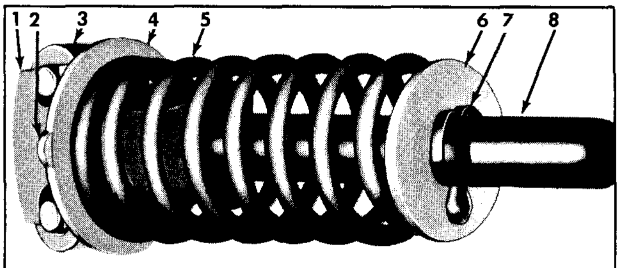
Figure 30—Stopmaster Brake Components (Automatic Adjuster with "Fail-Safe")



1 Retaining Cage
2 "Ears" on Washer
3 Roller
4 Wedge Retainer Washer
5 Wedge Return Spring
6 Return Spring Washer
7 Cotter Pin
8 Wedge

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Figure 31—Wedge and Roller Assembly

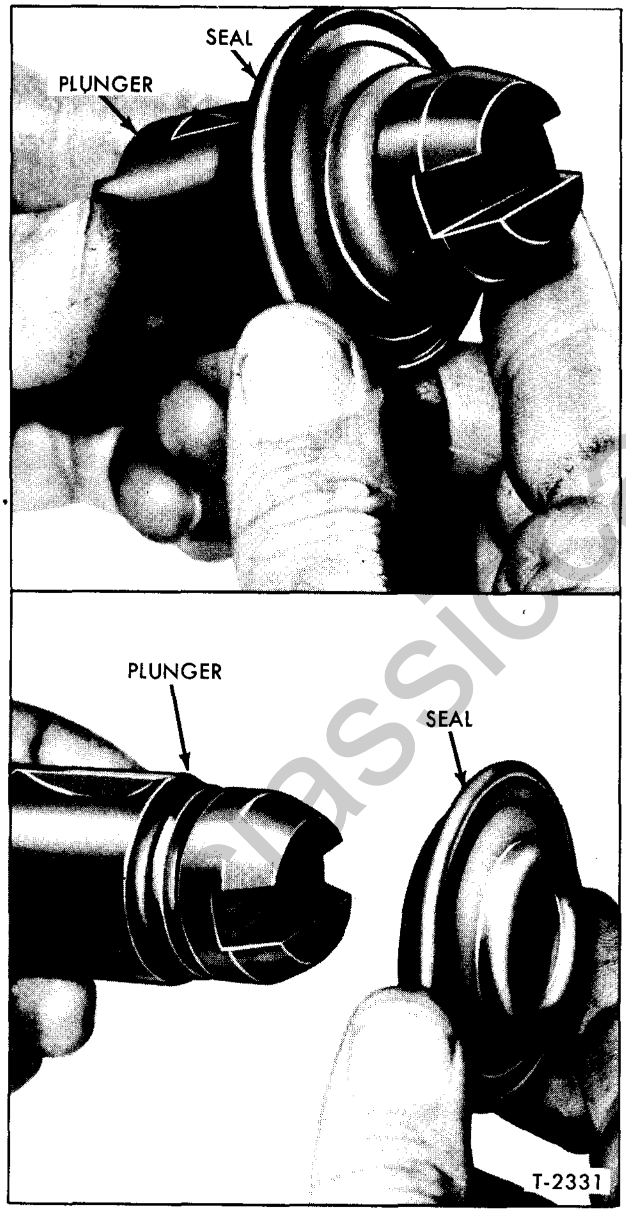


Figure 32—Installing Seal on Anchor Plunger

be properly upset. Maximum braking efficiency can be obtained immediately if linings are trued-up with a lining grinder so they are properly centralized in relation to center of hub.

BRAKE SHOE INSTALLATION
(Refer to Fig. 30)

1. Position brake shoe webs inside hold-down clips with ends engaging slotted end of anchor plungers and slotted end of adjusting bolt.

NOTE: Brake shoes are constructed with a 4-inch radius on the adjusting end and a 3-inch radius on the anchor end. When installing shoes on brake assembly, make certain the end marked as suggested in "NOTE" of Step 4 of "Removal" is mounted in adjusting plunger.

2. Install brake shoe return springs. Make certain hold-down clip applies pressure to shoe web to avoid cocked shoes.

BRAKE ACTUATION COMPONENTS

Actuation components can be serviced without removing spider from axle. Trouble diagnosis might indicate faulty internal part or parts which would not necessitate brake chamber disassembly or new brake lining. Actuation components should then be inspected for faulty or unacceptable conditions.

For service of automatic adjuster components see procedures under that subject on a previous page of this section. The following procedures cover the anchor end components and other actuation components.

REMOVAL (Refer to Fig. 30)

1. Remove drake chambers. Refer to procedures covering standard and/or "Fail-Safe chamber service.
2. Loosen spanner nut, then unscrew non-pressure housing from brake spider. This leaves wedge, roller and spring assembly exposed.
3. Remove wedge, roller and spring assembly from actuation housing by pulling straight out.
4. Remove brake shoes. Refer to procedure covering this operation.
5. Remove plunger guides and washers.
6. Pry plunger seal from spider housing.
7. Remove anchor plunger.
8. Remove automatic adjuster components as described in applicable procedures.

DISASSEMBLY OF WEDGE ASSEMBLY
(Refer to Figs. 30 and 31)

1. Remove cotter pin and wedge return spring washer from wedge assembly.
2. Slide wedge spring off wedge.
3. Remove wedge retainer washer and rollers from roller retaining cage.

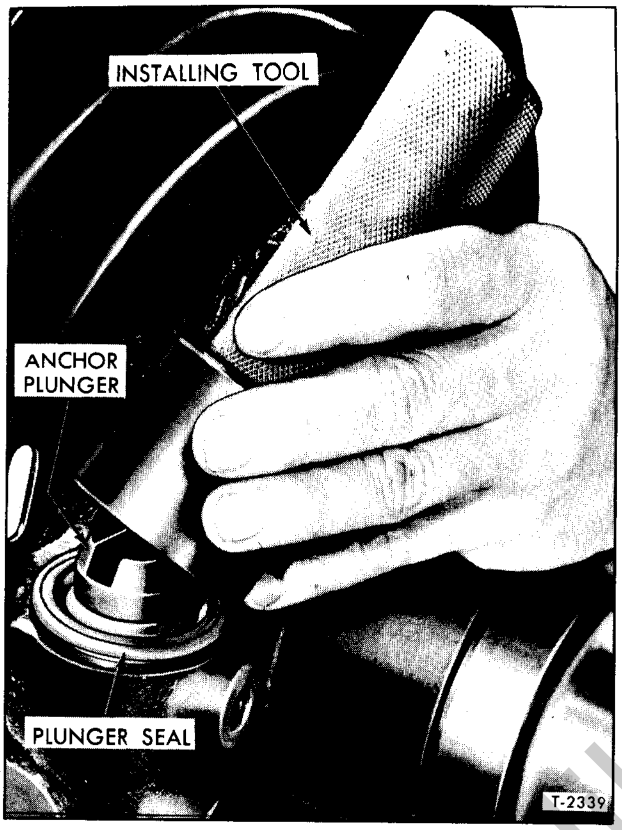


Figure 33—Installing Anchor Plunger and Seal

CLEANING AND INSPECTION

All components should be thoroughly cleaned prior to inspection and reassembly.

1. Inspect wedge for bent or distorted condition. Examine bearing surfaces for scoring or wear. Replace wedge if there is evidence of wear or distortion.

2. Examine rollers for any wear or out-of-round condition. No scratches or scoring is permissible.

3. Examine wedge spring for fatigue or corrosion. Replace spring if necessary.

4. Inspect actuation housing cylinder bores for scores, scratches, or corrosion. Light scratches or slightly corroded spots may be polished out with crocus cloth. Never use emery cloth or sandpaper. If scratches or corrosion are too deep to be polished out, spider must be replaced.

5. Inspect plungers for scoring, scratches, or corrosion. Light scratches may be polished out with crocus cloth. If scratches or corrosion are too deep to be polished out, plunger must be replaced.

6. Inspect plunger seal for any cracking or deterioration. Any deterioration is unacceptable and seal should be replaced.

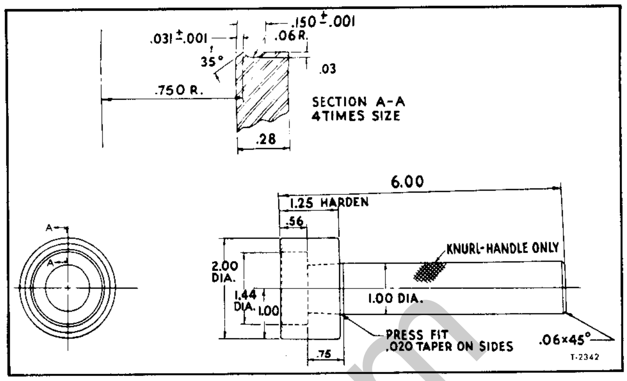


Figure 34—Plunger Seal Installing Tool Dimensions

ASSEMBLY OF WEDGE ASSEMBLY
(Refer to Figs. 30 and 31)

1. Install rollers in retaining cage.

2. Place washer in position on retaining cage.

3. Install wedge in retaining cage.

4. Position spring on wedge against washer and compress enough to install return spring washer and cotter pin.

INSTALLATION (Refer to Fig. 30)

1. Install new seals on anchor plungers as shown in figure 32.

2. Install plungers and seals in housing as shown in figure 33.

Figure 35—Installing Wedge Assembly

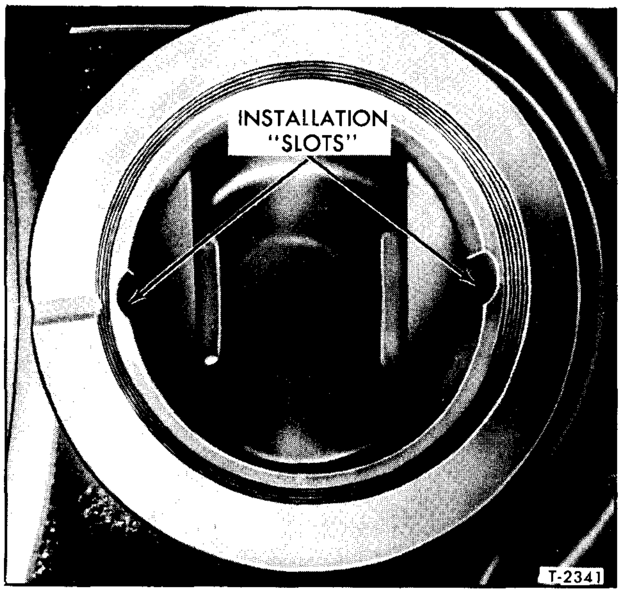


Figure 36—Wedge Cavity in Housing ("Slots" Shown)

NOTE: Installation tool shown in figure 33 can be made locally according to dimensions shown in figure 34.

3. Insert plunger guide with new washer inside slots in anchor plungers.

4. Install automatic adjuster components as detailed in applicable procedure.

5. Install wedge assembly in actuation housing (refer to fig. 35). Be sure rollers are seated correctly in retainer cage and make good contact with plungers.

NOTE: Spring retainer washer has "ears" on each side to be used as guides to assure correct installation (see fig. 31). Housing has "slots" to match "ears" on washer (see fig. 36).

6. Install brake shoes as previously described under "Brake Shoe Installation" in this section.

7. Install brake chambers as described previously.

8. Connect all air lines into both chambers.

9. Build up air pressure in system and push parking brake knob in to admit air into outer chambers (with "Fail-Safe" only).

10. With air in outer chambers, turn release bolt at each chamber (if "Fail-Safe") counterclockwise as far as it will go (approximately 18 turns - see fig. 39). Brakes are now in operating condition, either for service brakes or parking.

11. After brakes are in operating condition, adjust brakes and repeat operating and leakage tests as previously described.

STANDARD "FAIL-SAFE" BRAKE CHAMBERS

GENERAL

The Stopmaster Standard "Fail-Safe" is a mechanical actuation feature for power brakes and is two-fold in purpose. It is used as an air-released, spring-applied parking brake, as well as a safety feature in the event of air brake failure.

DESCRIPTION AND OPERATION

BRAKE CHAMBERS (Fig. 37)

Two brake chamber assemblies are used at each wheel. Type used differs by model as shown in figure 24. The "Fail-Safe" brake chamber assembly consists of an inner and outer chamber. The inner chamber, containing a diaphragm and diaphragm plate rod, serves as the service brake chamber and operates in the same manner as a conventional brake chamber. Movement of diaphragm plate rod is transmitted to the brake shoes through the mechanical actuating components as described later.

The outer chamber contains a spring-loaded piston which acts against the service brake chamber diaphragm plate rod. During normal operation, constant air pressure is applied to the outer chamber; this pressure, acting on the piston, holds the spring compressed. When air pressure is released from the outer chamber by pulling out the knob on the parking brake control valve, spring pressure forces the piston toward the service brake chamber; piston movement is transmitted through the service brake diaphragm plate rod to the brake actuating mechanism, applying the brakes.

This same action will take place in the event air pressure is lost from the system.

NOTE: The air tank supplying air pressure to the parking brake chambers is protected from the main air system by a one-way check valve; this tank will contain enough pressure for at least one parking brake release in case pressure is lost from the main air system.

In case of complete pressure loss, and pressure in the protected tank is depleted, brakes will remain applied until air pressure is restored. If necessary to move the vehicle before air pressure can be restored, brakes can be released by turning the release bolts clockwise as far as possible (approximately 18 turns) to compress the springs, as shown in figure 39. (This must be done at all "Fail-Safe" chambers at each wheel.) After air pressure has been restored, service brakes will be operative immediately; however, the parking brake will remain inoperative until the spring release bolts are backed out (counterclockwise) as far as possible to release the springs. Push parking brake valve knob in to released position to admit air into parking brake chambers to hold springs compressed while turning the release bolts.

> **CAUTION: Under no circumstances should any service operations be attempted on the brake chambers without first compressing the springs by means of the release bolts. Applying air pressure (at least 60 psi) to the parking brake chambers, either from the vehicle air system or from shop air supply, will hold springs compressed and facilitate turning bolts.**

MECHANICAL ACTUATING COMPONENTS
(Refer to Fig. 30)

When pressure is applied to the brake chamber diaphragm plate rod, either by air pressure during a service brake application or by spring pressure from the parking brake chamber, movement is transmitted to both ends of each brake shoe through wedges, rollers, and plungers which are installed in the actuating housing in the brake spider. One plunger for each shoe incorporates an adjusting wheel to provide a means of adjusting the brakes to compensate for normal lining wear. All Stopmaster brakes have automatic adjusters.

SERVICEABILITY TESTS

OPERATING TEST

1. Service Brakes

Make a brake application and check expansion of brake shoes against drum. Shoes should move freely and instantly when brake treadle is depressed. Release treadle. Shoes should contract and release brakes without any lag. Visually inspect entire lining area to see if lining is bearing properly on both sides.

2. Parking Brakes

Apply parking brakes by pulling knob of control valve to release air from chamber. Brakes should apply promptly and should hold on any grade on which vehicle is expected to operate. Release the brakes by pushing knob in. Brakes should release instantly and wheels turn freely.

LEAKAGE TEST

1. Service Brakes

With brakes applied, check air chambers for leakage at clamping ring by covering ring with soap suds. Also apply suds to drain holes on bottom of chamber. Any small air leaks should be evident. No leakage is permissible at either location. If leakage occurs at clamping ring, tighten clamping ring. If leakage persists, diaphragm may be damaged or not fitting properly between pressure and non-pressure housings (Figs. 37 and 38).

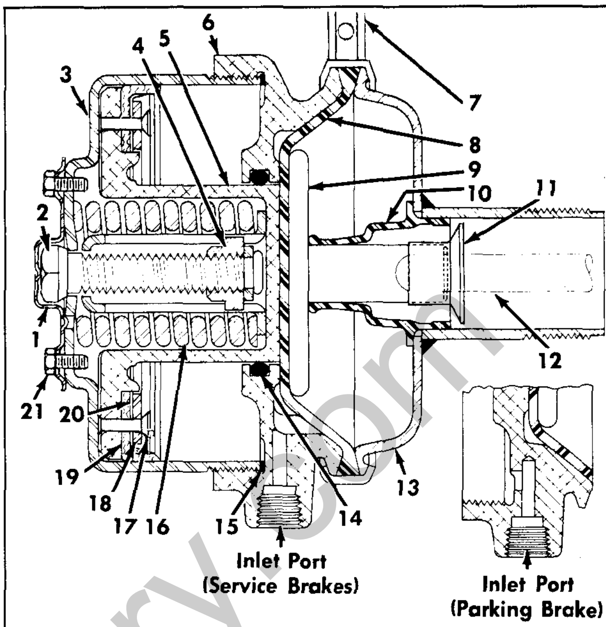
If air is escaping from drain holes only, it is an indication that diaphragm is faulty.

2. Parking Brakes

a. With parking brake released by air pressure, apply soap suds on cap around release bolt. Any leakage that is evident indicates a faulty piston seal. Seal should be replaced and suds applied again to be sure leakage has been corrected.

b. Soap suds should be applied at cap to pressure housing joint. If leakage is evident, fault could be due to distorted cap caused by careless handling or deteriorated rubber washer between cap and housing.

c. Coat service brake relay valve exhaust port with soap suds. Leakage at this point indicates leakage past O-ring seal in the pressure housing. If leakage occurs, replace O-ring with new part.



1 Spring Lock	12 Wedge Rod (Part of Wedge Assembly)
2 Release Bolt	13 Non-Pressure Housing
3 Spring and Cap Assembly	14 O-Ring
4 Release Bolt Nut	15 Rubber Washer
5 Piston	16 Spring
6 Pressure Housing	17 Rivet
7 Clamping Ring	18 Retainer Plate
8 Rubber Diaphragm	19 Piston Seal
9 Diaphragm Plate Rod	20 Expander
10 Rubber Boot	21 Spring Lock Capscrew
11 Wedge Rod Guide	

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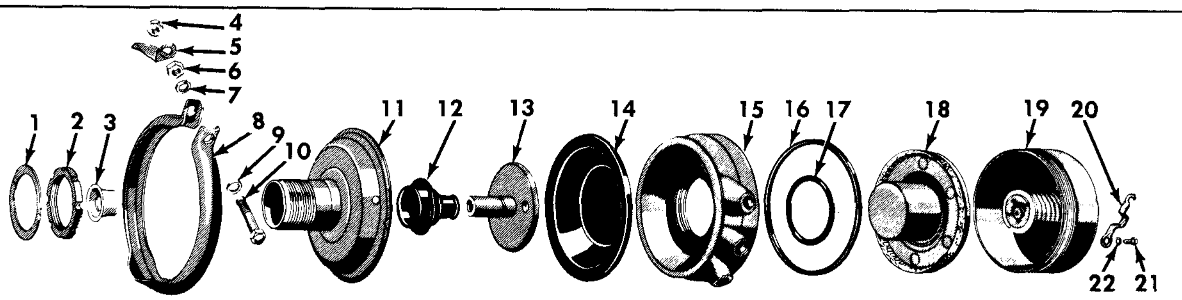
Figure 37—"Fail-Safe" Brake Chamber Assembly



1 Spanner Nut Retaining Washer
2 Spanner Nut
3 Wedge Rod Guide
4 Tag Nut
5 Caution Tag
6 Nut
7 Lock Washer
8 Clamping Ring
9 Washer
10 Bolt
11 Non-Pressure Housing
12 Push Rod Boot
13 Diaphragm Plate Rod
14 Rubber Diaphragm
15 "Fail-Safe" Pressure Housing
16 Housing to Cap Rubber Washer
17 Housing to Plunger "O" Ring
18 Air Chamber Piston Plunger Assembly
19 Air Chamber Cap Assembly
20 Release Bolt Spring Lock
21 Capscrew
22 Lock Washer

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Figure 38—"Fail-Safe" Air Chamber Components

SERVICING STANDARD "FAIL-SAFE" BRAKE CHAMBERS

Brake chamber components can be removed from the vehicle for inspection and replacement of parts without removing the non-pressure housing and without disturbing the mechanical actuating mechanism.

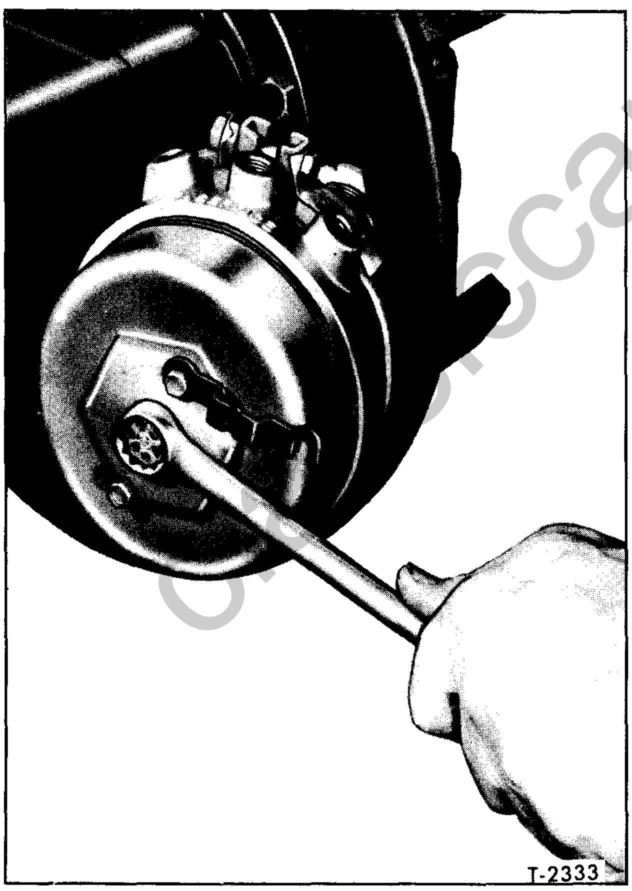


Figure 39—Compressing "Fail-Safe" Power Spring

REMOVAL AND DISASSEMBLY

Refer to figure 37 (also refer to figure 38 for components).

CAUTION: BEFORE ATTEMPTING BRAKE CHAMBER REMOVAL, BLOCK WHEELS SECURELY, SINCE PARKING BRAKE WILL NOT BE APPLIED.

1. With air pressure in parking brake chamber (brake released), loosen release bolt spring lock and swing to one side; then turn release bolt clockwise as far as it will go (approx. 18 turns) to compress the power spring. Refer to figure 39.
2. Exhaust air pressure from parking brake chamber by pulling parking brake knob out.
3. Disconnect air lines from both chambers.
4. Mark pressure housing and non-pressure housing so that parts can be reassembled in the same relative position. Loosen clamping ring by unscrewing bolt. Hang clamping ring on non-pressure plate tube.
5. Remove entire cap and spring assembly, pressure housing, and rubber diaphragm (see fig. 40). Diaphragm plate rod and boot will remain in the non-pressure housing.
6. Mount pressure housing in vise.

NOTE: DO NOT tighten vise jaws enough to distort pressure housing. Using a wrench on hex end of cap, unscrew cap and spring assembly from housing; OR mount hex end of cap in vise and, using special "strap" type wrench to remove pressure housing from cap assembly. See figures 41 and 42 for illustrations of this operation and dimensions to make a "strap" wrench.

7. Remove washer and O-ring from pressure housing.

8. Remove piston assembly from cap by pulling straight out. At times the spring, when fully compressed, cocks slightly. It is then necessary to loosen the release bolt a few turns so that the piston can be withdrawn easily.

9. The piston, retainer plate, seal and expander are held together by rivets. If any part of this assembly is defective the complete assembly must be replaced. Details are not serviced separately.

10. Cap and spring assembly is serviced as a unit. If any of the parts become damaged or need replacing, it is necessary to replace the complete cap and spring assembly.

CAUTION: DO NOT attempt to disassemble the cap and spring assembly. In the event any part of this assembly is defective, the complete assembly must be replaced. The component parts are not serviced separately.

CLEANING AND INSPECTION
(Refer to Figs. 37 and 38)

1. It is recommended that all brake chambers be removed, disassembled, inspected, and thoroughly cleaned at the time that brakes are relined or at one year periods, whichever occurs first (also dependent upon type of operation and operators experience).

2. Clean all metal parts thoroughly, using a suitable cleaning fluid. Blow dry with air or wipe dry with cloth.

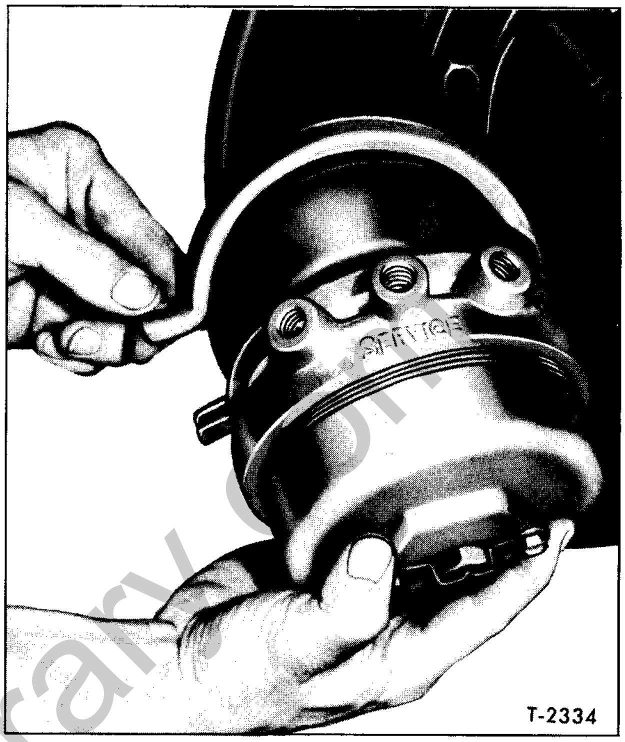


Figure 40—Removing "Fail-Safe" Assembly

3. Inspect piston cap for signs of damage or excessive wear. Piston should slide freely inside cap assembly. Replace piston if badly worn or damaged.

4. Inspect inside walls of cap assembly for scratches, scores, or excessive wear. Slightly worn spots may be removed with crocus cloth.

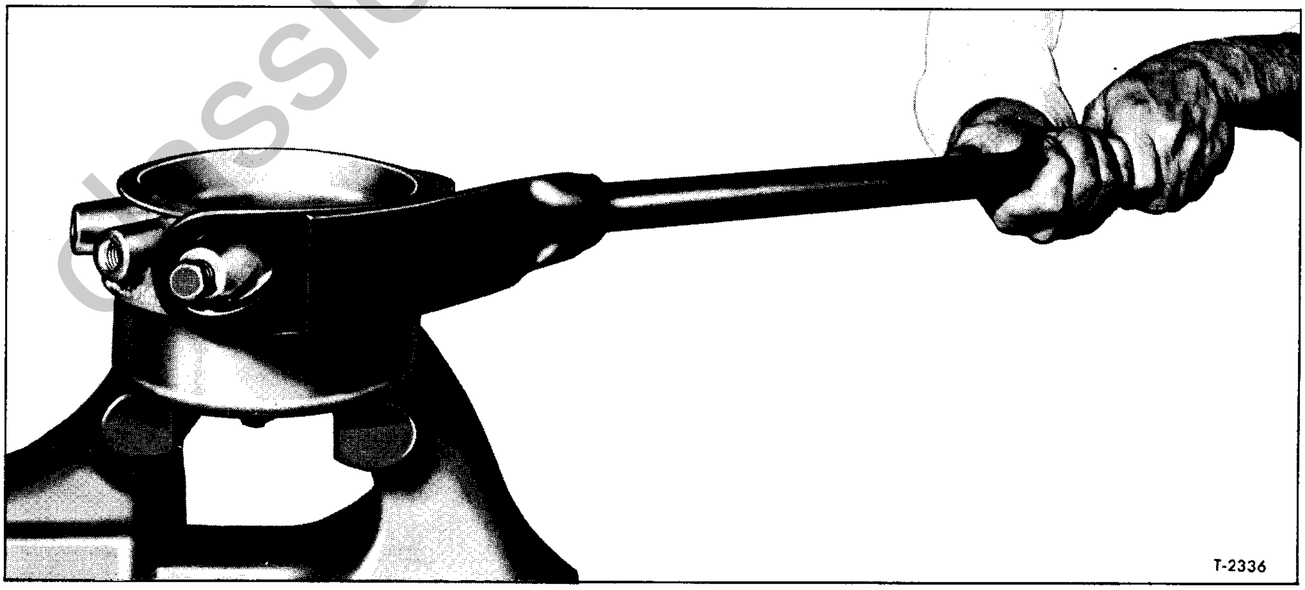


Figure 41—Removing Pressure Housing with "Strap" Wrench

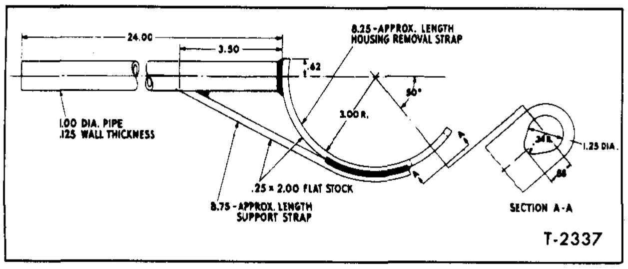


Figure 42—"Strap" Type Wrench Dimensions

Inspect threads on cap for rust or corrosion.

5. Inspect piston seal for cracking or deterioration. Inspect expander and expander retaining plate for deterioration. Replace piston assembly if necessary.

6. Inspect pressure housing for scratches, scores, or excessive wear. Examine all parts for obstructions and remove any foreign matter.

7. Examine spring in cap for deterioration or rust. Inspect release bolt for signs of rust on threaded portion. Unless spring or bolt is in very bad condition, replacement should not be necessary. See "Caution" in Step 10 of "Removal and Disassembly," previously.

8. Discard O-ring and rubber washer. Replace with new parts.

9. Examine diaphragm plate rod boot (in non-pressure housing) for deterioration or cracks. If deterioration or other damage is evident, replace as follows:

a. Pull diaphragm plate rod, wedge rod guide and boot out of wedge rod and mounting tube respectively.

b. Remove guide and boot from diaphragm plate rod and install new boot on plate rod. Replace wedge rod guide.

c. Apply a liberal amount of rubber cement to boot flange and mating surface on non-pressure housing.

d. Position plate rod on wedge rod and hold rubber boot flange tightly against housing surface. Flange should seal tight to keep any moisture or foreign matter from falling into actuation components.

NOTE: Be careful not to disturb wedge and roller mechanism inside actuation housing when repositioning plate rod on wedge rod.

BRAKE CHAMBER ASSEMBLY
AND INSTALLATION

Refer to figure 37 (also fig. 38 for components).

1. Install O-ring in groove in pressure housing.

2. Install piston assembly in cap assembly.

3. Position rubber washer in pressure housing at bottom of internal threads. Thread cap and spring assembly into pressure housing and tighten firmly against rubber washer. This may be done with "strap" type wrench (see figs. 41 and 42) or by putting pressure housing in vise and using a wrench on hex end of cap.

4. Position diaphragm over plate rod, then install pressure housing and cap assembly.

NOTE: Diaphragm should fit evenly between pressure housing and non-pressure housing. Align marks made on housings at disassembly to ensure proper air port location.

5. Pull clamping ring over flange of pressure and non-pressure housings. Install clamp bolt and nut and tighten firmly.

6. Connect all air lines and build up air pressure in system to normal operating pressure. Push parking brake knob in to admit air to outer brake chamber.

7. Turn release bolt counterclockwise as far as possible (approx. 18 turns) to release spring (fig. 39). This will leave the parking brake chamber in operating condition.

NOTE: It is best to have at least 60 psi of air in chamber to hold spring tension off nut so a better "feel" is obtained when the nut does bottom.

SUPER "FAIL-SAFE" BRAKES

The Super "Fail-Safe" Brake is identical to the Standard "Fail-Safe" Brake in operation and principle but differs physically in size and components. Refer to figure 43 for illustration of complete Stopmaster brake assembly with Super "Fail-Safe" chamber.

The Super "Fail-Safe" is a spring-powered brake actuator that mounts "piggy-back" on the air chamber non-pressure housing of the Stopmaster brake (see fig. 44).

When 65 psi or more of air pressure is applied against the piston, the power spring will be held in a compressed position. When air pressure is removed, the power spring will push the piston against the diaphragm plate. The wedge head will be pushed deeper between the rollers spreading the plungers apart and applying the brake.

The unit is equipped with a manual release bolt to permit safe handling for service. The cap cavity is sealed by an O-ring on the release bolt.

An internal venting system working in conjunction with a breathing arrangement on cap allows system air to fill vacuum behind piston when "Fail-Safe" is actuated and keeps unit sealed from direct atmospheric contamination.

The "Fail-Safe" is used as an air-released, spring-applied parking brake, as well as a safety feature in the event of air brake failure.

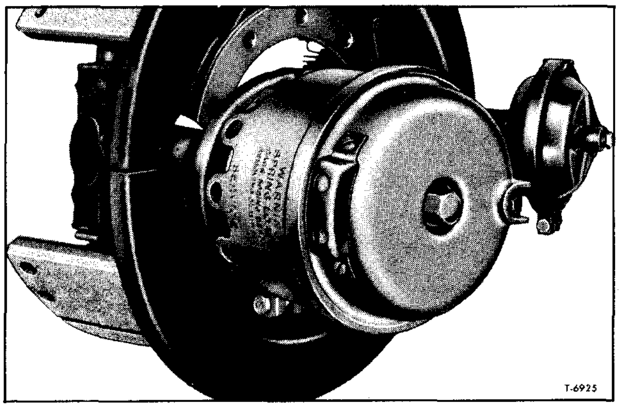
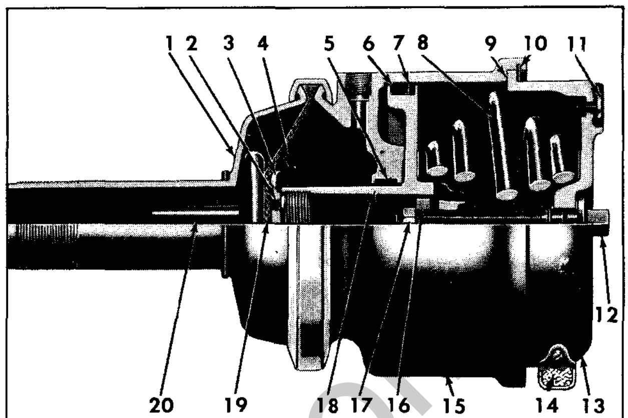


Figure 43—Brake Assembly with Super "Fail-Safe"



1 Non-Pressure Housing
2 Setscrew
3 Foot
4 Piston Seal
5 O-Ring
6 O-Ring
7 Back-up Ring
8 Power Spring
9 Rubber Seal
10 Lock Ring
11 Breather
12 Release Bolt
13 Cap
14 Filter
15 Housing
16 Square Nut
17 Hex Nut
18 Piston
19 Diaphragm
20 Push Rod

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Figure 44—Super "Fail-Safe" Assembly

SAFETY PRECAUTIONS

When brakes are equipped with Super "Fail-Safe" units, cage the power spring before starting any disassembly or removal of wheels or drums to avoid possible injury.

When a vehicle is disabled, due to low or lost air pressure, block the wheels and cage the power spring before attempting to move the vehicle.

SERVICE RECOMMENDATIONS

CAGING AND UNCAGING POWER SPRING

On the Super "Fail-Safe" the head of the release bolt is exposed at all times.

The power spring is caged by rotating the release bolt 18 to 21 full turns clockwise. Do not force the bolt beyond its normal stop.

Both the caging and uncaging operation can be made easier by applying air pressure (65 psi min.)

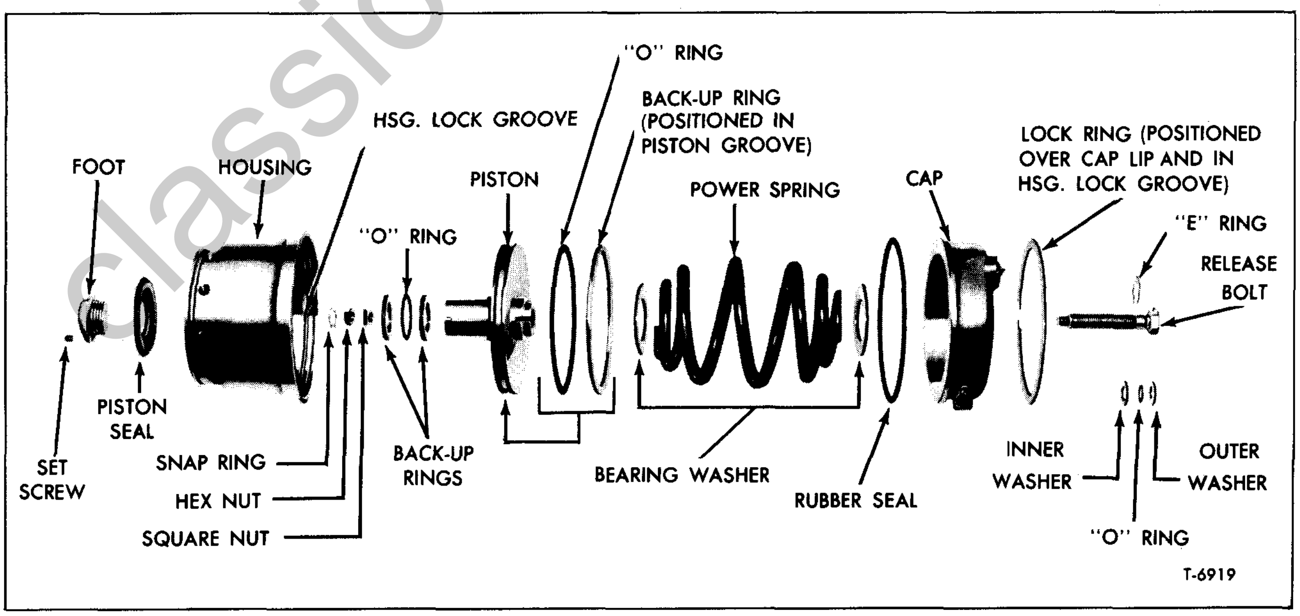


Figure 45—Super "Fail-Safe" Components

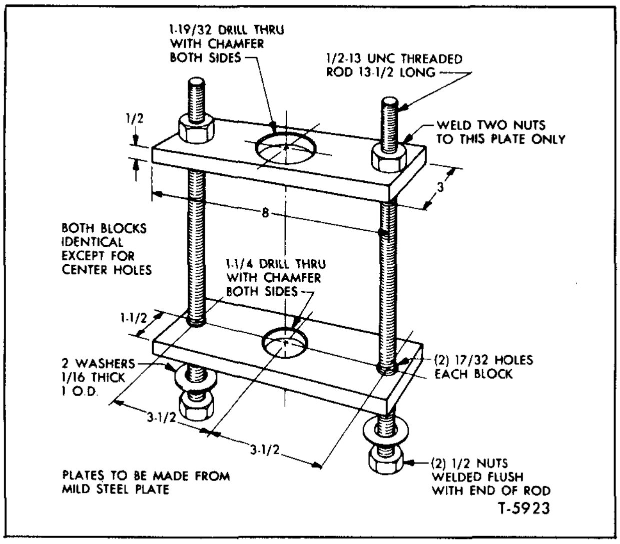


Figure 46—Power Spring Compressing Fixture

to the "Fail-Safe." This will take the spring load off the release bolt.

DISASSEMBLY (Refer to Fig. 45)

1. Cage power spring by turning release bolt 18 to 21 turns clockwise.
2. Remove "Fail-Safe" from non-pressure housing at clamp ring.
3. Release foot setscrew.
4. Unscrew foot from piston.
5. Remove piston seal.
6. Remove sealing compound located at joint between cap and housing.
7. Remove lock ring from housing.
8. Separate cap, spring, and piston assembly from housing. Remove rubber seal from housing.
9. Remove back-up rings and O-ring from groove in housing.
10. Remove snap ring and hex nut from release bolt.
11. Secure cap, spring, and piston assembly in fixture.

NOTE: Refer to figure 46 for illustration of fixture. This fixture is necessary to hold the power spring in compression for disassembly. This fixture is special tool number J-23527.

12. Turn release bolt until square nut falls free.
13. Release pressure on fixture until spring is unloaded.
14. Remove assembly from fixture.
15. Separate cap from spring and piston assembly.
16. Remove back-up ring and O-ring from piston.
17. Remove the two spring bearing washers.
18. Remove "E" ring and inner washer from release bolt.

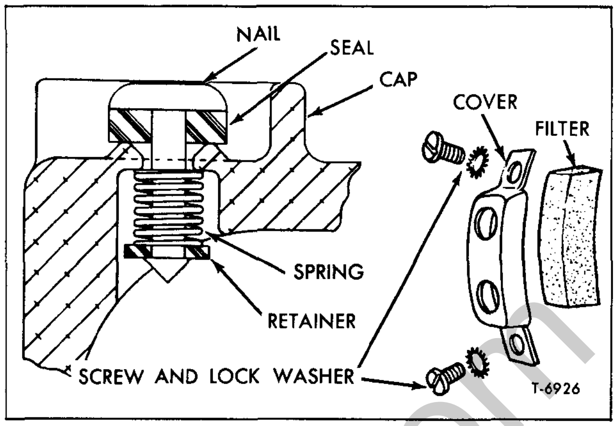


Figure 47—Breather and Filter Assembly

19. Remove bolt from cap. Remove O-ring and outer washer from release bolt.
20. Remove filter from cap.

IMPORTANT: DO NOT remove breather assembly from cap unless inspection indicates damage. It is necessary to cut the nail to remove the assembly.

ASSEMBLY

Before assembly, clean and inspect all parts. Lubricate with recommended grease (S28); refer to LUBRICATION (SEC. 0) in this manual. DO NOT lubricate cap in the area of the breather assembly. DO NOT use solvent on back-up or O-rings. Use hot soapy water and wipe clean.

It is necessary to use a sealer on the foot setscrew and cover the head of it with plastic tape until the sealer sets.

IMPORTANT: Replace sealing compound over cap lock ring to seal unit from contamination.

If breather assembly has been removed from cap, perform first four steps of following procedure. Otherwise start assembly procedure with Step 4. Refer to figure 47.

1. Insert nail through opening in seal.
2. Insert assembly through hole in cap and insert spring over nail.
3. Force retainer over flared end of nail.
4. Install filter on cap.
5. Install outer flat washer and O-ring on releast bolt.
6. Install release bolt in hole in center of cap with bolt head toward outside of cap.
7. Install inner flat washer and "E" ring on release bolt.
8. Install two spring bearing washers; one on piston and one in cap.
9. Install the back-up ring and O-ring on the piston.
10. Assemble cap assembly, spring, and piston. Compress assembly in fixture (fig. 46).

11. Install square nut on release bolt. Remove assembly from fixture.

12. Install hex nut and snap ring on release bolt.

13. Install back-up rings and O-ring in groove in housing.

14. Assemble cap, spring, and piston assembly in housing assembly, with rubber seal between cap and housing.

15. Install lock ring in housing and seal joint between cap and housing with sealing compound.

16. Install piston seal in housing.

17. Thread foot through housing into piston.

18. Lock foot in place with setscrew. Apply sealing compound to cover head of setscrew. Cover with plastic tape until sealer sets.

BRAKE CHAMBERS (ANCHORLOK)

"Anchorlok" brake chambers are used as optional equipment on some models. See figure 48 for illustration of "Anchorlok" brake chamber installed.

The "Anchorlok" chamber is used as a service brake chamber, an emergency brake in case of air pressure loss and a spring-applied parking brake. It consists of two separate air chambers, each having its own diaphragm and push rod. In the front chamber, air pressure enters behind the diaphragm when brake pedal is pushed, causing a service brake application, just as in any standard chamber. The rear chamber is subject to constant air pressure in front of the diaphragm, compressing the emergency parking spring. In the event of loss of air pressure in the rear chamber or intentional exhausting of pressure by the driver, the spring will apply the brakes. Application will begin when pressure drops to approximately 45 psi and will be complete when pressure reaches approximately 25 psi.

MANUAL RELEASE

In the event of an automatic emergency application (loss of air pressure) and it is necessary to move the vehicle before air pressure can be restored, the emergency parking spring can be compressed mechanically to release brake. A spring "caging" tool is part of the chamber assembly. Remove nut and release stud from its storage place on chamber body. Remove spring housing rubber cap and insert stud in hole. Secure stud in place (¼ turn) and "cage" spring by tightening nut with wrench. Directions are also given for this operation on the body of the chamber (fig. 49). This same procedure is followed if the chamber is to be removed from the vehicle for service.

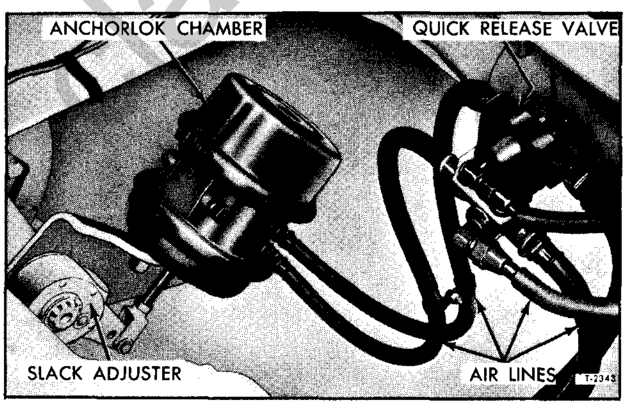


Figure 48—"AnchorLok" Brake Chamber Installed

APPLICATION

A manual emergency application (or parking application) may be made by the driver by pulling out the knob on the instrument panel which controls manual application. Release of a parking or emergency application can be made by pushing in this same knob, provided there is at least 45 pounds pressure in the air brake system.

BRAKE CHAMBER REPLACEMENT

Removal

1. Block vehicle wheels.

2. With brakes released, remove "spring-caging" tool from its storage place. Remove spring housing rubber cap, insert stud in hole and

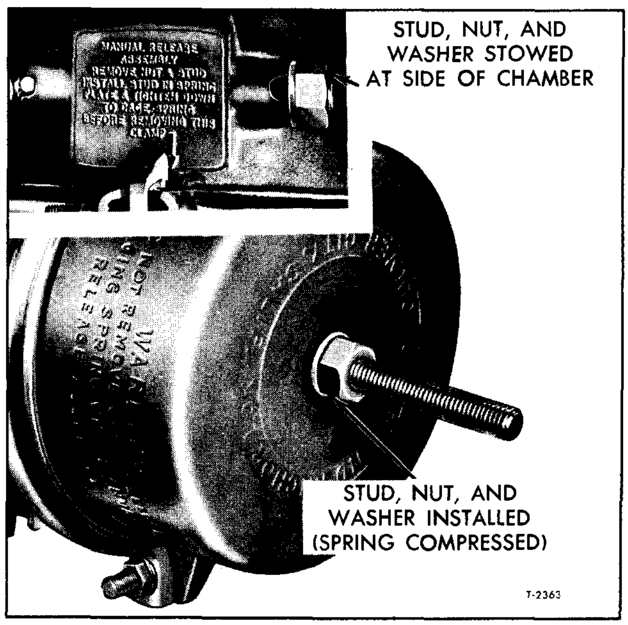


Figure 49—Spring Compressing Assembly

turn ¼ turn. Run nut down on stud until finger tight, then use wrench to turn nut at least three turns. Spring is now "caged."

NOTE: If both chambers are to be removed, perform Step 2 on each BEFORE proceeding further.

3. Open air tank drain valves and exhaust pressure from brake system.
4. Disconnect air lines at chamber.

NOTE: If only the emergency parking chamber needs to be removed, this may be done at this point by removing rear clamp ring and lifting rear chamber assembly off front (service) chamber.

5. Disconnect push rod clevis from slack adjuster.
6. Remove nuts and lock washers from mounting studs.
7. Remove "Anchorlok" brake chamber from mounting bracket.

Installation

1. Place "Anchorlok" chamber in position on mounting bracket.
2. Install lock washers and nuts on studs.
3. Connect push rod clevis to slack adjuster.
4. Connect air lines at chamber.
5. Start engine and build up air pressure to operating level. Make sure knob is pushed in on emergency parking brake valve on instrument panel.
6. Back off nut from "caging" stud in end of chamber. Remove stud and replace in storage pocket on chamber housing. Instal rubber cap over release stud hole.
7. Check operation of brakes.
8. Check for air leaks.

GENERAL TROUBLESHOOTING CHART

NO BRAKES PROBABLE CAUSE	REMEDY
1. No air pressure	1. Check for leaks, broken lines, etc. Repair or replace as necessary
2. Restricted tubing or hose	2. Replace defective parts.
3. Defective brake valve	3. Repair or replace

INSUFFICIENT BRAKES PROBABLE CAUSE	REMEDY
1. Low brake line pressure	1. Check for leaks, etc. and repair
2. Too much push rod travel	2. Adjust
3. Worn linings or drums	3. Replace as necessary
4. Leaking chamber diaphragm	4. Replace diaphragm
5. Slack adjusters out of adjustment	5. Adjust
6. Wrong size brake chambers	6. Replace according to "Specifications"

SLOW BRAKE APPLICATION PROBABLE CAUSE	REMEDY
1. Low brake line pressure	1. Check for leaks, etc. and repair
2. Linkage binding	2. Lubricate linkage
3. Too much push rod travel	3. Adjust
4. Restriction in line	4. Remove restriction or replace line
5. Leaking brake valve	5. Repair or replace
6. Worn linings or drums	6. Replace as necessary
7. Leaking chamber diaphragm	7. Replace diaphragm
8. Brake shoe anchor pins frozen	8. Free up, replace or lubricate as necessary
9. Foot control valve linkage improperly adjusted	9. Adjust
10. Camshaft bushings binding or worn	10. Lubricate or replace

SLOW BRAKE RELEASE PROBABLE CAUSE	REMEDY
1. Linkage binding	1. Lubricate linkage
2. Restriction in line	2. Remove restriction or replace line.
3. Too much push rod travel	3. Adjust
4. Improper seating of valves in application valve.	4. Repair or replace
5. Binding cam or camshafts	5. Lubricate if possible; replace if not effective.
6. Weak shoe return springs	6. Replace springs

GRABBING BRAKES PROBABLE CAUSE	REMEDY
1. Grease or dirt on lining	1. Clean or reline.
2. Brake drum out-of-round	2. Turn or replace
3. Defective application valve	3. Repair or replace

UNEVEN BRAKES PROBABLE CAUSE	REMEDY
1. Uneven slack adjuster settings	1. Adjust properly
2. Linkage binding at one or more wheels	2. Lubricate as necessary
3. Linings worn uneven	3. Adjust or replace
4. Brake shoe return spring weak or broken	4. Replace
5. Defective brake chamber	5. Repair or replace
6. Defective brake drum	6. Repair or replace
7. Unequal springs in brake chambers or between brake shoes	7. Replace in pairs.

SLOW PRESSURE BUILDUP IN RESERVOIRS PROBABLE CAUSE	REMEDY
1. Clogged air cleaner	1. Clean or replace
2. Air leak	2. Find and repair
3. Faulty compressor	3. Repair (see "Air Compressor" section in this manual)
4. Open or leaking reservoir drain cocks.	4. Close, repair or replace.
5. Defective compressor governor	5. Repair or replace

AIR PRESSURE ABOVE NORMAL PROBABLE CAUSE	REMEDY
1. Defective air gauge	1. Replace
2. Governor out of adjustment or defective	2. Adjust, repair or replace
3. Restricted line between governor and compressor	3. Clear line or replace
4. Compressor unloader inoperative	4. Repair or replace

QUICK LOSS OF PRESSURE WHEN ENGINE IS STOPPED (BRAKES NOT APPLIED) PROBABLE CAUSE	REMEDY
1. Leaking lines or connections	1. Repair or replace
2. Worn or leaking compressor exhaust valve or one-way check valve.	2. Repair or replace
3. Leaking governor	3. Repair or replace
4. Leaking application valve	4. Repair or replace
5. Open or leaking reservoir drain cock	5. Close, repair or replace
(BRAKES FULLY APPLIED)	
1. Leaking brake chamber	1. Repair or replace
2. Leaking application valve	2. Repair or replace
3. Leaking service line	3. Repair or replace
4. Leaking chamber hoses	4. Repair or replace
5. Dirt in two-way check valve. (If equipped with hand control valve and brakes are applied by the foot valve, dirt in the two-way check valve could cause a pressure leak at the hand valve exhaust port.)	5. Clean or replace
6. Defective quick release valve	6. Clean or replace diaphragm.

SAFETY VALVE "BLOWS OFF" PROBABLE CAUSE	REMEDY
1. Safety valve out of adjustment	1. Adjust
2. Pressure in system above normal	2. See chart on "Air pressure above normal"
3. Governor out of adjustment	3. Adjust

STOPMASTER TROUBLESHOOTING CHART

"FAIL-SAFE" PARKING BRAKE WILL NOT RELEASE — PROBABLE CAUSE	REMEDY
1. Air leak in "Fail-Safe" lines	1. Check air system and correct leaks
2. Loose clamp ring or cap	2. Tighten and check for air leaks
3. Leakage at release bolt	3. Replace piston and seal assembly
4. Faulty piston O-ring seal	4. Replace piston O-ring seal
5. Foreign material in "Fail-Safe" chamber	5. Clean with solvent and lubricate
6. Improper wedge adjustment	6. Make wedge adjustment
7. Corroded "Fail-Safe" spring	7. Replace cap and spring assembly

"FAIL-SAFE" PARKING BRAKE WILL NOT APPLY — PROBABLE CAUSE	REMEDY
1. "Fail-Safe" spring not fully released	1. Turn release bolt counterclockwise
2. Inoperative parking brake control valve or quick release valve	2. Check operation of valves as outlined in Maintenance Manual and replace if necessary
3. Foreign material in chambers or piston stuck in cap	3. Disassemble and clean with solvent; lubricate piston and cap
4. "Fail-Safe" spring failure	4. Replace cap and spring assembly
5. Rollers not aligned with plungers or wedge not mated with diaphragm plate rod	5. Remove non-pressure housing and check installation of wedge
6. Brakes out of adjustment	6. Adjust brakes; check operation of automatic adjusters

AUTOMATIC ADJUSTERS INOPERATIVE — PROBABLE CAUSE	REMEDY
1. Guide installed backwards	1. Remove plunger guide components and reassemble
2. Guide spring missing or weak	2. Replace guide spring
3. Plunger seal failure	3. Replace seal; clean and lubricate actuation parts
4. Adjusting bolt threaded into actuator too tight	4. Back off bolt 1/4 turn
5. Plunger guide washer omitted	5. Replace washer

SERVICE BRAKES INOPERATIVE PROBABLE CAUSE	REMEDY
1. Low air pressure	1. Check system for leaks
2. Faulty brake chamber diaphragm	2. Replace diaphragm
3. Improper brake shoe adjustment	3. Adjust brake shoes
4. Improper wedge adjustment	4. Make wedge adjustment
5. Plunger seal failure	5. Replace seal and clean and lubricate actuation parts
6. Grease on linings	6. Reline brakes and check seals

SPECIFICATIONS

FRONT BRAKES

FRONT AXLE MODEL	F070 F090(1)	F090(2) F120	F160(3)	FE900(3)
Brake Size	15 x 3	15 x 3½	17¼ x 3½	16¼ x 3½
Brake Shoe Lining				
Width	3″	3½″	3½″	3½″
Thickness	7/16″	7/16″	7/16″	½″
Area (sq. in. per axle)	190	221	249	238
Brake Chamber				
Type	12	16	20	16
Diameter	5 23/32″	6 11/32″	6 25/32″	6 11/32″
Adjust Travel to	← Short as possible without brakes dragging →			
Slack Adjuster				
Type	PL-18	PL-18	PL-18	PL-18
Length Between Hole Centers	4½″-5½″	4½″-5½″	5″-6″	4½″-5½″

(1) When used on JV 70.
(2) When used on other than models in note (1).
(3) Optional axles on some models.

REAR BRAKES EXCEPT STOPMASTER

TRUCK SERIES	TM70	TV70
Brake Size	15 x 6	15 x 7
Brake Shoe Lining		
Width	6″	7″
Thickness	¾″	¾″
Area (sq. in. per axle)	377	440
Brake Chamber		
Type	30	30
Diameter	8⅛″	8⅛″
Adjust Travel to	Short as possible without brakes dragging	
Slack Adjuster		
Type	PL-24	PL-24
Length Between Hole Centers	5½″	6″

STOPMASTER BRAKE SPECIFICATIONS

TRUCK SERIES	HM, JM, JV70	SEE NOTE (1)	SEE NOTE (2)
Brake Size	15 x 5	15 x 6	15 x 7
Brake Shoe Lining			
Width	5″	6″	7″
Thickness	¾″ Crescent	49/64″ Crescent	¾″ Crescent
Area (sq. in. per axle)	307	368	440
Brake Chamber			
Standard			
Diameter (at clamp band)	5.66″	5.66″	5.66″
Fail Safe			
Diameter (at chamber body)	5.264″	5.264″	5.264″

Note (1): Used on following models: HV70, JE, JN90; DC90 with SLHD axle; DH, DI90 with E34DS, SLHD, and 34D3 axles; DN90 with E34D3, E34DS, and SLHD axles.

Note (2): Used on following models: HI, HN, JI, MH, MI90; FC, FH, FI, FN90; DC, DH90 with SQHD and SSHD axles; DI, DN90 with SQHD axle.

PARKING BRAKES

EXTERNAL CONTRACTING BAND TYPE BRAKE

External contracting band type parking brake is mounted at rear of transmission (fig. 1).

Brake drum is attached to the transmission output shaft flange in conjunction with the propeller shaft universal joint flange. The band and lining assembly is supported around the drum by a bracket on the adjustment side and an anchor bar on the stationary side. Both supports are attached to the transmission case. The band contracts around the drum when brake is applied.

Linkage connecting parking brake lever to brake operating cams varies on different models, however, adjustment is made at brake assembly in same manner.

BAND TYPE ADJUSTMENT (Fig. 1)

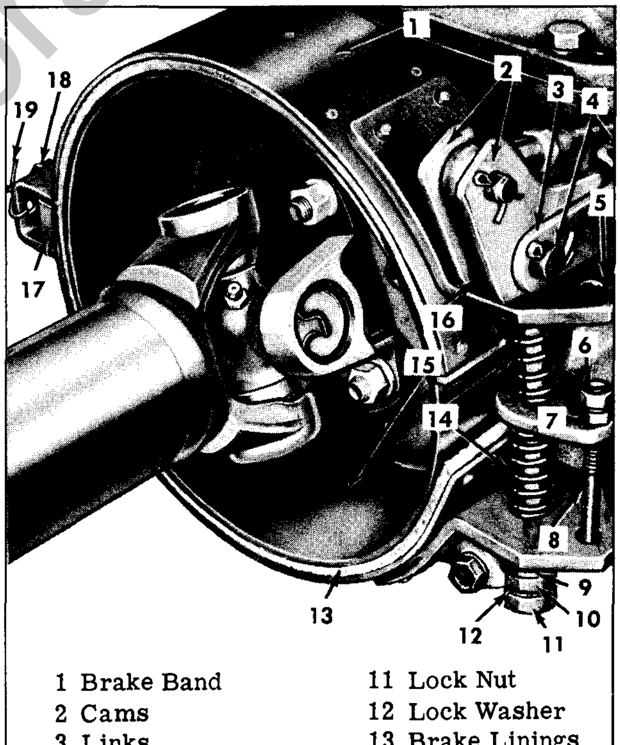
1. Place hand lever in fully released position. Disconnect brake rod or cable from operating cams by removing cotter pin and clevis pin.
2. Remove lock wire from anchor adjusting screw and turn anchor screw as necessary to obtain 0.005" to 0.015" between lining and drum. Install lock wire in anchor screw.
3. Loosen lock nut on locating bolt and tighten adjusting nut on locating bolt until there is a clearance of 0.020" to 0.040" between lower end of lining and drum. Measure clearance about 3 inches from end of lining. When correct clearance is obtained, tighten lock nut on locating bolt.
4. Loosen lock nut on adjusting bolt and tighten adjusting nut on adjusting bolt to obtain clearance of 0.020" to 0.040" between upper end of lining and drum. Measure clearance about 3 inches from end of lining. Tighten lock nut on adjusting bolt.
5. Adjust end on brake rod so that clevis pin may be freely inserted through operating cams and rod end. Install clevis pin and cotter pin, then tighten lock nut on rod end. A 0.005" shim must pass freely between drum and lining.

BRAKE BAND REMOVAL (Fig. 1)

1. Disconnect brake rod or cable from operating cams. Remove clevis pin and operating cams from upper end of adjusting bolt.
2. Remove nuts and washers from lower end of adjusting bolt. Lift adjusting bolt straight up out of brake band brackets and support, stripping release springs and cam shoe from bolt as bolt is removed.
3. Remove nuts from locating bolt, then remove bolt.
4. Remove lock wire from anchor screw, then back screw out until clear of anchor bar.
5. Slide band and lining assembly straight to rear off brake drum and anchor bar (fig. 1), removing band and lining assembly off over propeller shaft.

INSPECTION

1. Examine braking surface of drum for roughness or scoring. If drum is worn or damage, it must be replaced.
2. Inspect brake lining. If worn down close to rivet heads, new lining must be installed.
3. Examine tension and release springs; replace if weak or broken.



1 Brake Band	11 Lock Nut
2 Cams	12 Lock Washer
3 Links	13 Brake Linings
4 Clevis Pins	14 Release Springs
5 Cam Shoe	15 Brake Drum
6 Lock Nut	16 Adjusting Bolt
7 Adjusting Nut	17 Anchor Bar
8 Locating Bolt	18 Anchor Screw
9 Washer	19 Lock Wire
10 Adjusting Nut	

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Figure 1—External Contracting Band Parking Brake

BRAKE BAND INSTALLATION (Fig. 1)

1. Place band and lining assembly over propeller shaft. Place anchor screw spring in depression of anchor bar, and compress spring as band anchor bracket is placed over anchor bar.

2. Install anchor screw through bracket and spring into anchor bar. Insert locating bolt up through band lower bracket and hole in support and install nuts temporarily.

3. Place operating cams between links and install new clevis pin and cotter pin.

4. Insert threaded end of adjusting bolt down between operating cams with hook toward rear of vehicle. As bolt is lowered into place it must pass through cam shoe, band upper bracket, upper release spring, brake support, lower release spring, and band lower bracket. Install flat washer, adjusting nut, lock washer, and lock nut on adjusting bolt.

5. Adjust lining to drum clearance and connect brake rod as directed under "Band Type Adjustment."

BRAKE DRUM REMOVAL

1. Remove brake band and lining assembly.

2. Remove nuts and lock washers from bolts attaching propeller shaft U-joint flange and brake drum to transmission output shaft flange. Telescope propeller shaft at slip joint and lower end of propeller shaft to floor. Remove if necessary, nuts, lock washers, and bolts attaching propeller shaft center bearing hanger bracket to crossmember.

3. On some vehicles, brake drum is mounted on forward side of transmission mainshaft companion flange, and on other vehicles it is mounted on rear side of flange. If mounted on rear side of flange, drum may be removed without removing flange; if mounted on forward side of flange, remove retaining nut and flange from output shaft. Press serrated bolts from flange to separate drum from flange.

BRAKE DRUM INSTALLATION

1. Wipe mating surfaces of brake drum and output shaft flange clean. Position brake drum on flange and press serrated bolts into place. Replace drum assembly and retaining nut on output shaft. See "Specifications" in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B) in this manual for nut torque on various transmission models.

2. Position propeller shaft flange against brake drum (or output shaft flange). If removed, attach propeller shaft center bearing hanger bracket to crossmember. Replace all lock washers and nuts and tighten securely.

3. Install brake band and lining assembly and adjust brake.

INTERNAL EXPANDING TYPE BRAKE

Internal expanding type parking brake is mounted at rear of transmission. Brake support plate is attached to transmission rear bearing cap or retainer with four bolts. Brake drum is mounted between universal joint flanges and is secured with eight bolts. When used as an emergency brake, at start of braking action, brake shoes are forced out against drum by a lever-operated cam. The self-energizing action of both shoes then completes brake application.

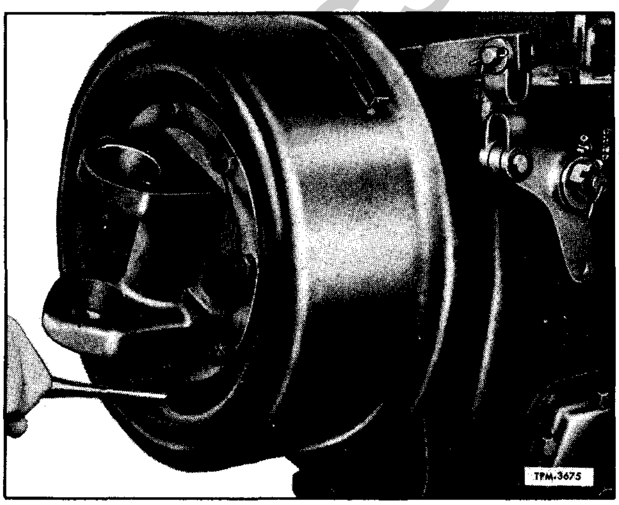


Figure 2—Internal Expanding Type Brake Adjustment

NOTE: Except in case of an emergency, set parking brake only after vehicle is brought to a complete stop. Parking brake is not designed for regular use in place of service brakes.

PARKING BRAKE ADJUSTMENT (Fig. 2)

A brake adjustment should be made before it becomes necessary to pull hand brake lever to limit of travel to obtain a full brake application.

1. Jack up at least one rear wheel. Block wheels and release hand brake.

2. Remove cotter pin and clevis pin connecting pull rod and relay lever. This will assure freedom for full shoe release.

3. Rotate brake drum to bring one of access holes into line with adjusting screw at bottom of shoes.

4. Expand shoes by rotating adjusting screw with screwdriver inserted through hole in drum. Move outer end of screwdriver away from drive shaft. Continue adjustment until shoes are tight

against drum and drum cannot be rotated by hand. Back off adjustment four (4) notches and check drum for free rotation.

5. Place parking brake lever in fully released position. Take up slack in brake linkage by pulling back on control lever just enough to overcome spring tension. Adjust clevis of pull rod to line up with hole in relay lever. Insert clevis pin and cotter pin, then tighten clevis lock nut.

6. Lower rear wheels. Remove jack and wheel blocks.

BRAKE DRUM REMOVAL

1. Jack up at least one rear wheel. Block wheels and release parking brake.

2. Disconnect universal joint at brake drum, as instructed under applicable heading in "PROPELLER SHAFTS" (SEC. 4D) in this manual.

3. Remove eight nuts and lock washers holding yoke flange and brake drum. Remove yoke flange. Lift drum carefully off mounting bolts to avoid damage to threads.

BRAKE DRUM INSTALLATION

1. Lift brake drum and install carefully over brake shoes and onto eight mounting bolts. Install yoke flange and eight nuts and lock washers. Tighten nuts alternately and evenly.

2. Adjust brake as directed under "Parking Brake Adjustment."

3. Connect propeller shaft universal joint as directed in "PROPELLER SHAFTS" (SEC. 4D) in this manual.

BRAKE SHOE REMOVAL (Fig. 3)

NOTE: Output shaft flange is removed in figure 3 for clarity of illustration; it is not necessary to remove flange to remove brake shoes.

1. Remove two return springs and anchor pin link from cam ends of brake shoes. Spread ends of brake shoes far enough to permit removal from support plate. Remove shoes, then separate by removing adjusting screw and adjusting screw spring.

2. Replace lining if worn down close to rivet heads. Rivet new lining securely and evenly on shoes.

3. Inspect two shoe return springs, and adjusting screw spring. Parts damaged or worn should be replaced with new parts.

BRAKE SHOE INSTALLATION (Fig. 3)

1. Apply thin coat of S17 Special Lubricant on surface of support plate at points in contact with brake shoes. Apply S17 sparingly to socket end of adjusting screw and install adjusting screw socket.

2. Insert adjusting screw between adjusting ends of brake shoes. Adjusting wheel should be nearest left shoe. Install adjusting screw spring.

3. Spread apart cam ends of brake shoes. Lift shoes vertically and push into position on support plate. Install anchor pin brace and two shoe return springs.

SUPPORT PLATE REMOVAL (Fig. 3)

1. Remove propeller shaft flange at mainshaft as directed in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B) of this manual.

2. Remove brake shoe and lining assemblies.

3. Remove cotter pin and clevis pin attaching control lever to link.

4. Mark control lever and camshaft so that parts may be properly reassembled. Loosen clamp bolt and slide control lever off serrated camshaft. Remove camshaft from camshaft bracket.

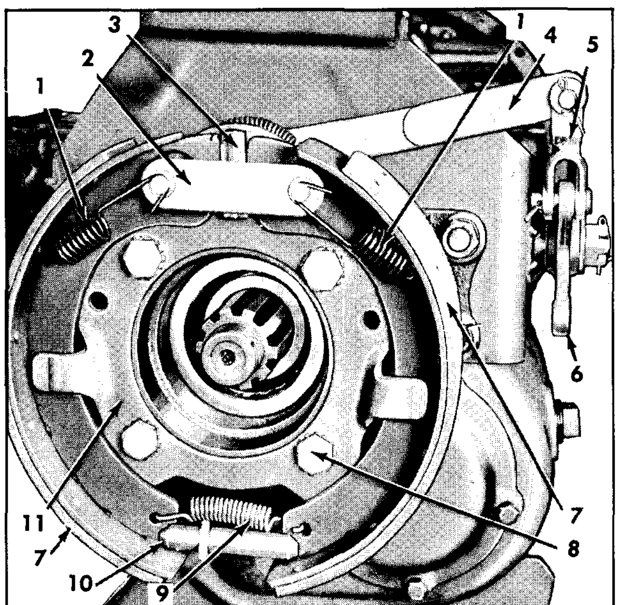
5. Remove bolts attaching plate to transmission rear bearing cap, then remove plate.

6. Remove cotter pin, nut, washer, and relay lever. Inspect relay lever bushing. Replace damaged or badly worn bushings.

SUPPORT PLATE INSTALLATION (Fig. 3)

1. Position support plate on pilot of transmission rear bearing cap or retainer and align bolt holes. Insert four bolts and tighten securely.

2. Install camshaft in camshaft bracket. Align



1 Return Springs	7 Brake Shoe
2 Anchor Pin Link	8 Plate Bolt
3 Camshaft	9 Adjusting Screw Spring
4 Control Lever	10 Adjusting Screw
5 Link	11 Support Plate
6 Relay Lever	

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Figure 3—Internal Expanding Type Brake Installed

control lever mark with mark on camshaft and install control lever. Tighten clamp nut.

3. Install brake shoe and lining assemblies.

4. Install propeller shaft flange at mainshaft as directed in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B) in this manual.

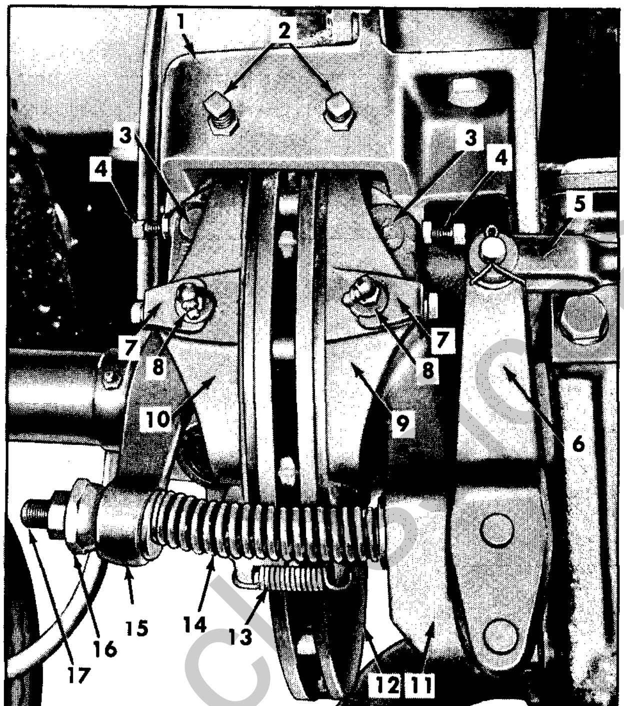
5. Replace relay lever, washer, and nut on shaft. Tighten nut lightly, then back up to first hole and install new cotter pin. Nut should not be tight enough to restrict movement of relay lever. Insert clevis pin through holes in control lever and link and secure with new cotter pin.

TRU-STOP (DISC TYPE) BRAKE

This type brake is used only on models when equipped with auxiliary transmission. The ventilated brake disc is mounted between the propeller shaft flange and the auxiliary transmission shaft companion flange. Brake shoes are mounted in opposed positions with brake disc between, as shown in figure 4. When brake is applied, the shoes are forced against disc.

TRU-STOP BRAKE ADJUSTMENT

Disc type brake should be adjusted before a full brake application requires brake lever to be pulled to travel limit.



1 Brake Support Bracket
2 Parallel Adjusting Screws
3 Front Lever Arm Pin
4 Pin Retaining Screw
5 Brake Cable Clevis
6 Brake Lever
7 Brake Shoe Pin Retainer
8 Brake Shoe Pin
9 Front Brake Shoe
10 Rear Brake Shoe
11 Front Lever Arm
12 Brake Disc
13 Tension Spring
14 Spring
15 Rear Lever Arm
16 Adjusting Nut
17 Tie Rod

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Figure 4—Tru-Stop Type Parking Brake

1. Disconnect brake cable or rod clevis from brake lever.

2. Tighten adjusting nut until spring exerts enough pressure to bring lever against front lever arm.

3. Insert a 1/32" shim between rear shoe lining and brake disc.

4. Tighten adjusting nut until front shoe lining is firmly against disc, yet still allowing removal of shim.

5. Make sure tension spring is in place. Adjust parallel adjusting screws so that both linings are parallel with disc. This provides 1/64" clearance between front and rear shoe linings and brake disc at all points.

6. Make sure brake lever in cab is in fully released position. Adjust clevis on brake cable as necessary to permit installation of clevis pin through clevis and brake lever without changing position of lever. Install clevis pin and cotter pin.

7. Make sure lock nuts on brake cable and adjusting screws are firmly tightened.

BRAKE SHOE REMOVAL (Fig. 4)

1. Remove lock nut and adjusting nut from tie rod. Remove tension spring.

2. Move lever in cab to fully applied position so that rear lever arm can be swung clear of tie rod. Remove washers and spring from tie rod.

3. Remove brake shoe pin retainer cap screws and retainers. Remove brake shoe pins, then remove shoe and lining assemblies.

4. If shoe linings are worn down close to rivet heads, remove old lining and install new lining. Make sure that new linings are securely and evenly riveted to shoes.

BRAKE SHOE INSTALLATION (Fig. 4)

1. Position brake shoes on lever arms and install brake shoe pins. Install brake shoe pin retainers and cap screws.

2. Place spring and washers on tie rod. Swing rear lever arm forward and insert tie rod through hole in bottom of arm.

3. Move lever to released position and install tension spring.

4. Install adjusting nut and lock nut. Adjust brakes as directed under "Tru-Stop Brake Adjustment."

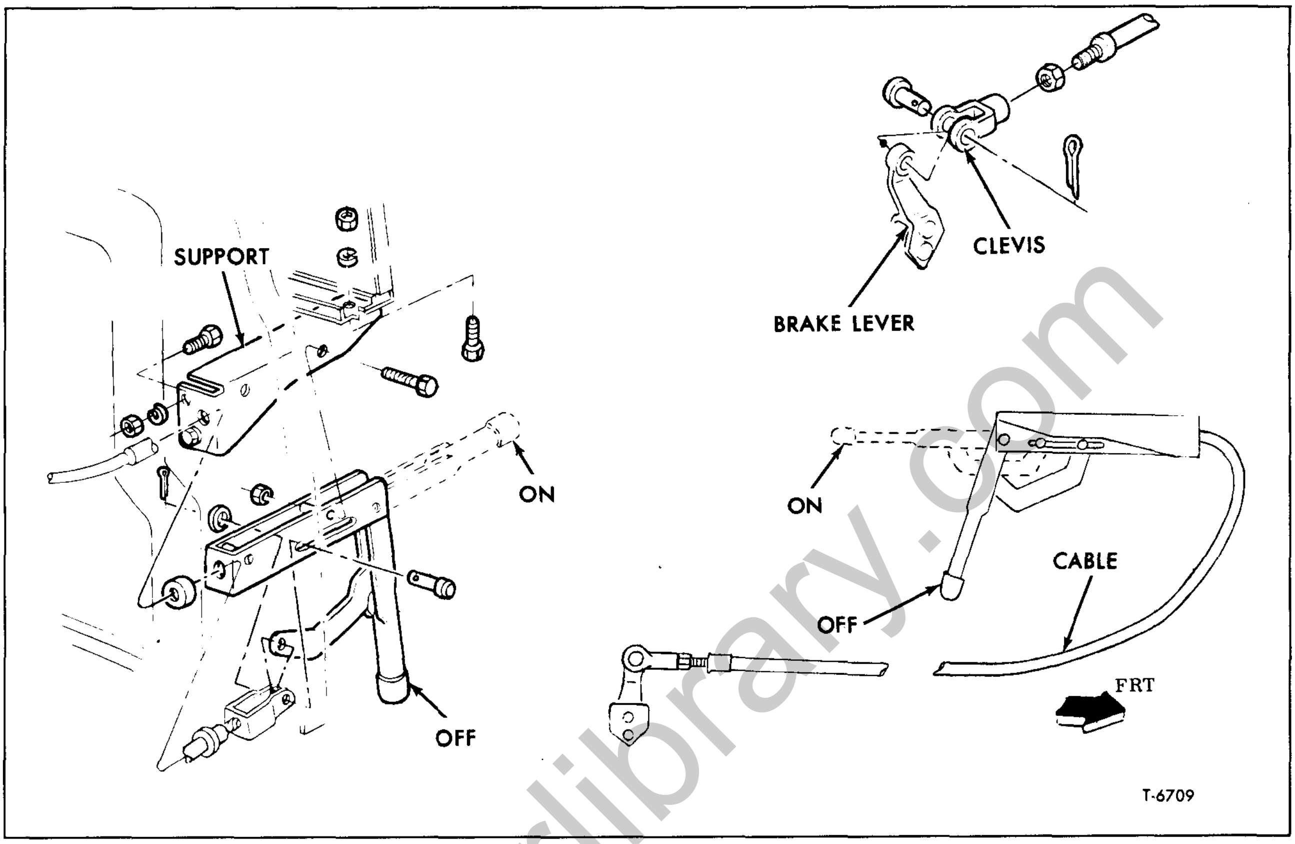


Figure 5—Orscheln Brake Lever Linkage Adjustment

ORSCHELN-TYPE BRAKE LEVER

Orscheln-type brake levers are used on all models covered by this manual which have mechanically actuated parking brakes. This type lever is mounted in the cab and is connected to the brake at rear of transmission by a flexible cable. A cam arrangement with an "over-center" position locks lever in applied position. A knurled knob at the end of the lever can be adjusted to vary the amount of pull required to apply the brake, at the same time making a minor adjustment in the degree of brake application.

LINKAGE ADJUSTMENT (Fig. 5)

1. Place brake lever in "OFF" position.
2. Adjust clevis and nut to provide for free pin at brake lever.
3. Pull brake lever to "ON" position. Check for brake holding ability.
4. Readjust if necessary.

STOPMASTER "FAIL-SAFE" BRAKES

Stopmaster "Fail-Safe" parking brakes are used as standard equipment on some models, and as optional equipment on other models, covered by this manual. When Stopmaster brakes with the "Fail-Safe" feature are used no other parking brake system is required. For all information relative to these brakes refer to "Stopmaster Brakes" in "AIR BRAKES" (SEC. 5B) of this manual.

ANCHORLOK BRAKE CHAMBERS

The "Anchorlok" brake chamber is used as optional equipment on some models. This chamber incorporates a spring applied, air pressure released parking/emergency brake and is covered in "AIR BRAKES" (SEC. 5B) of this manual.

SPECIFICATIONS

Brake Type	Drum & Band	Drum & Band	Drum & Band	Drum & Band	Internal Two-Shoe	Tru-Stop	Tru-Stop
Brake Size	9½ x 2½″	9½ x 3″	10½ x 3″	11½ x 3½″	12 x 3″	14″	16″
Brake Drum Diameter	9½″	9½″	10½″	11½″	12″	14″ disc	16″ disc
Lining Length (approx.)	27″	27″	33 1/32″	36″	13⅝″	10 13/16″	12 15/32″
Lining Width	2½″	3″	3″	3½″	3″	2½″	3″
Lining Thickness	3/16″	3/16″	5/16″	5/16″	9/32″	¼″	¼″
Total Lining Area (Sq. In.)	67.5	81.0	99.1	126.0	83.8	44.2	60.7

GASOLINE ENGINES

Contents of this section are listed in Index below:

ENGINE APPLICATION CHART

TRUCK MODEL	ENGINES Standard	Optional
HM 80	401M	478M
JM 80	401M	478M*
TM 80	401M	478M
* Vehicles with Air Brakes only.		

GENERAL INFORMATION

To assure satisfactory performance, the engine must be tuned at regular intervals. Frequency of tune-up is largely dependent upon the type of service in which the vehicle is used.

In addition to the regular engine tune-up, the other units and systems which relate to engine performance must be serviced periodically as part of the engine maintenance program.

Refer to appropriate manual section for information on engine accessory units not covered herein.

This section of manual provides instructions for servicing the various items and tuning the engine. Unless otherwise stated, the procedures are applicable to all gasoline engines used in vehicles covered by this section. To adequately accomplish a satisfactory tune-up, reliable test equipment in the hands of trained personnel is necessary.

ENGINE LUBRICATION

NOTE: Figure 1 is a schematic diagram showing lubrication passages in V6 engines.

The high capacity, rotor type oil pump is driven by a shaft which engages socket at lower end of ignition distributor.

Oil pump draws oil through screened inlet near bottom of oil pan, and discharges oil under pressure through oil galleries and passages as schematically illustrated.

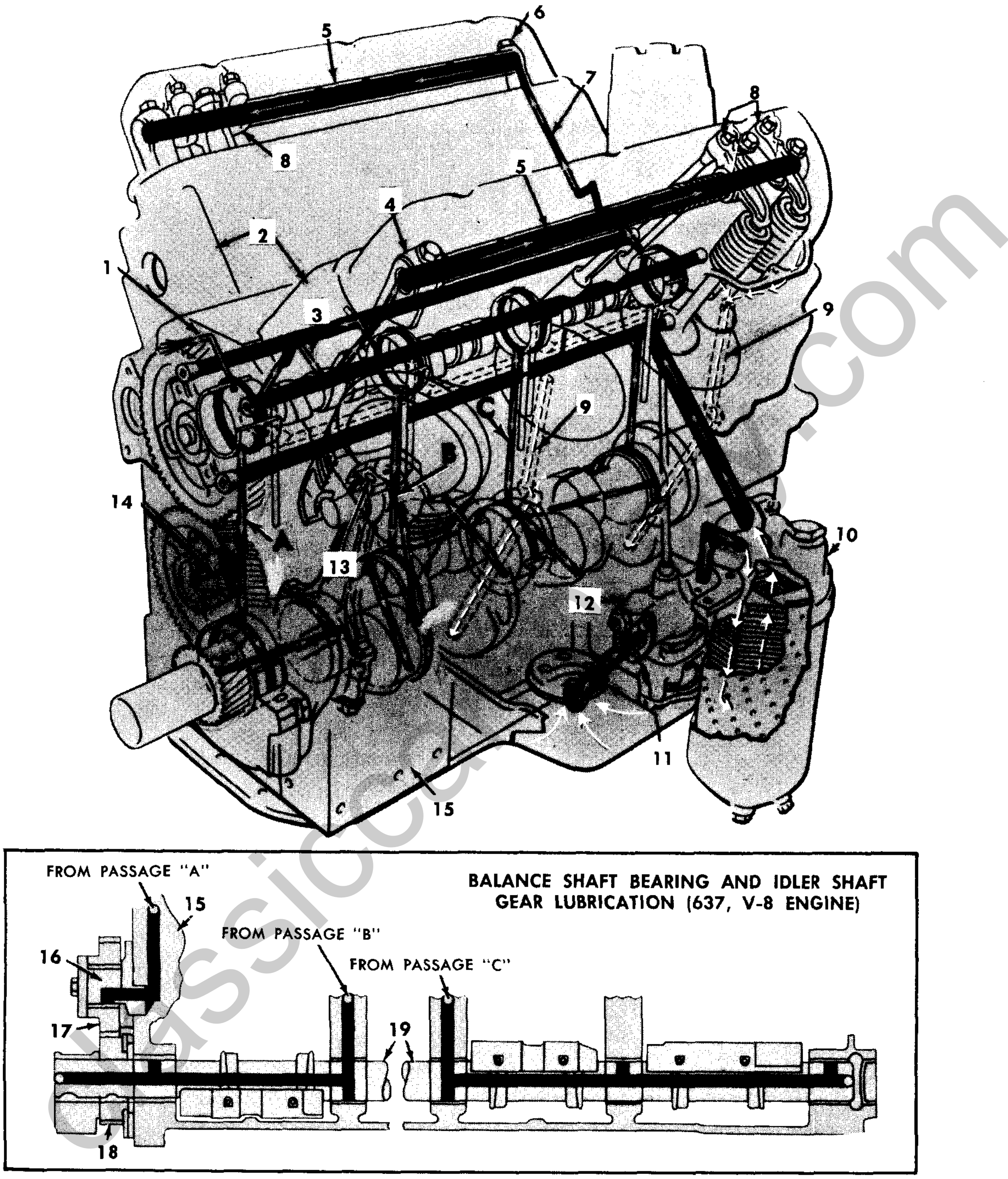
With hydraulic type governor the spinner valve assembly is mounted on bottom of oil pump and is driven by a coupling which engages oil pump rotor shaft.

Full-flow type oil filter is replaceable element type. Oil filter has a by-pass valve which allows oil to flow directly into engine oil galleries to provide lubrication in case filter element should become clogged.

LUBRICATION AFTER STORAGE

If engine has not been run for some time (as when vehicle has been in prolonged storage) the lubrication system should be primed to assure immediate lubrication when engine is started.

A pressurized container containing engine oil may be used to force oil through oil passages in engine.



1 To Timing Gears
2 Cylinder Heads
3 Oil From Camshaft Front Bearing
4 Rocker Arm Shaft Front Bracket
5 Rocker Arm Shafts
6 Rocker Arm Shaft Rear Bracket
7 Oil From Camshaft Rear Bearing
8 Rocker Arms
9 Oil Drain Back Holes
10 Oil Filter
11 Oil Pump Inlet Screen
12 Oil Pump
13 Piston Pin Splash Lubricated
14 Timing Idler Gear Shaft
15 Cylinder Block
16 Balance Shaft Idler Gear Shaft
17 Balance Shaft Idler Gear
18 Balance Shaft Gear
19 Balance Shaft

T-2187

Figure 1—Engine Lubrication System

Remove the oil pressure sending unit and connect oil supply at 30 psi for minimum of 15 seconds.

An alternate method for forcing oil through engine galleries is to remove ignition distributor, then use a speed wrench or electric drill motor and 5/16-inch deep socket to spin the oil pump drive shaft. This will displace any air and fill passages with oil to ensure positive lubrication to all bearings as soon as engine is started.

ENGINE MAINTENANCE AND TUNE-UP

ENGINE MAINTENANCE

SERVICING AIR CLEANERS

Carburetor air cleaners are provided on all vehicles. For location of air cleaners, recommended service intervals, and servicing procedures, refer to FUEL SYSTEM (SEC.6M) in this manual.

CHECKING AND MAINTAINING CRANKCASE OIL LEVEL

Daily, or oftener if necessary, check oil level. Check when at operating temperature, and after engine has been stopped for at least five minutes. Remove dipstick, wipe clean, reinsert and remove again. The upper mark on dipstick is "FULL," the lower "ADD" or "ADD OIL." Keep level as close as possible to "FULL" mark without over-filling. Do not operate with level below "ADD" or "ADD OIL" mark. Dipstick is at the right side of engine. Add oil through filler cap opening in valve rocker arm cover.

When replenishing oil supply in crankcase, add oil of same brand and quality as is used when changing oil.

Refer to LUBRICATION (SEC. 0) in this manual for recommendations pertaining to oil change intervals and oil filter replacement intervals.

REPLACING OIL FILTER ELEMENT

1. Remove filter drain plug and allow oil to drain from housing. Use wrench to loosen filter housing bolt, then remove bolt, housing, and filter element as an assembly. Remove housing gasket.

2. Remove element from housing and discard element. Clean housing thoroughly. Also clean filter bracket.

3. Install new element in housing shell and position new gasket at filter bracket. Fill the filter with engine oil, then install shell and element assembly. Tighten the filter shell center bolt to 45 foot-pounds torque.

4. Start engine and inspect for oil leaks. If necessary, add oil to raise oil level to "FULL" mark on dip stick.

CHECKING DRIVE BELTS

1. Inspect drive belts for excessive wear and damage. If no defects are found, check belts for proper tension.

2. When installing new drive belts or adjusting old belts use tension gauge to provide correct tension.

CAUTION: Adjusting drive belts too tightly will impose too great a load on bearings in the driven units. Slipping will occur if drive belts are not adjusted tight enough. Belt life will be shortened if belts are not properly tightened.

TUNE-UP, CHECKS, AND ADJUSTMENTS

TUNE-UP SEQUENCE INDEX

INTRODUCTION

Engine tune-up consists of diagnosis, and the required preventive maintenance performed at regular intervals to provide maximum performance and economy.

A systematic procedure must be followed when tuning an engine. The operations should be performed in sequence suggested by "Tune-up Sequence Index on previous page.

NOTE: When performing work where electrical terminals could be accidentally grounded, disconnect the battery cables so no damage to circuits will result.

ENGINE TUNE-UP

SPARK PLUG REMOVAL

1. Clean all foreign matter away from around spark plugs and wiring using compressed air. Disconnect spark plug wires, and loosen each spark plug one turn.

2. Reconnect plug wires, start engine and accelerate to approximately 1,000 rpm. This is done to blow away loose dirt particles and carbon. Failure to do this increases the possibility of foreign material lodging under valves, with resultant false readings and possible valve damage.

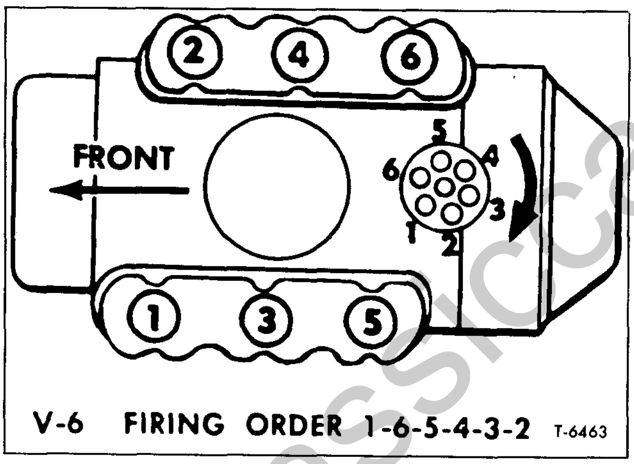


Figure 2—Cylinder Numbering and Spark Plug Wire Locations for V6 Engine

3. Stop engine, disconnect plug wires and remove spark plugs and gaskets.

CYLINDER COMPRESSION TEST

1. With carburetor choke and throttle in wide-open position, operate starter with remote control switch.

CAUTION: When using remote switch to operate starter, the primary wire must be disconnected from coil negative terminal and ignition switch must be turned on. Failure to do this will result in damaged grounding circuit in ignition switch.

2. Starting with compression gauge at zero, crank engine through at least four compression strokes to obtain highest possible reading.

3. Make compression check at each cylinder and record each reading.

4. If some cylinders have low compression, inject about one tablespoon of engine oil into combustion chamber through spark plug hole. Crank engine to spread oil on cylinder walls, then recheck compression with gauge.

a. If compression is higher but does not necessarily reach normal pressure, worn piston rings are indicated.

b. If compression is not improved by adding oil to cylinder, it is probable that valves are not properly seating possibly due to sticking in guides, or burned valves or seats.

c. If two adjacent cylinders have lower than normal compression, and injecting oil into cylinders does not increase compression, the cause may be a head gasket leak between the cylinders. This condition could be cause of coolant leaking into cylinders.

NOTE: An engine with low or uneven compression cannot be tuned to give peak performance; therefore, it is important to make necessary corrections before proceeding with tune-up operations.

SERVICE AND INSTALL SPARK PLUGS

1. Inspect all spark plugs carefully. Look for glazed, broken, or blistered porcelains and burned electrodes.

2. If spark plugs are serviceable, use an abrasive type cleaner such as sand blaster to thoroughly clean spark plugs. File end of center electrode flat.

3. Adjust spark plug gaps to specifications.

4. Test spark plugs with spark plug tester. When replacing spark plugs, use the type of plugs listed in "Engine Tune-up Specifications."

5. Install spark plugs using new gasket. Use torque wrench and special spark plug socket wrench. Correct torque for spark plug installation is 32 foot-pounds.

IGNITION SYSTEM SERVICE

1. Remove equipment as required to provide access to ignition distributor, spark plug wires and coil.

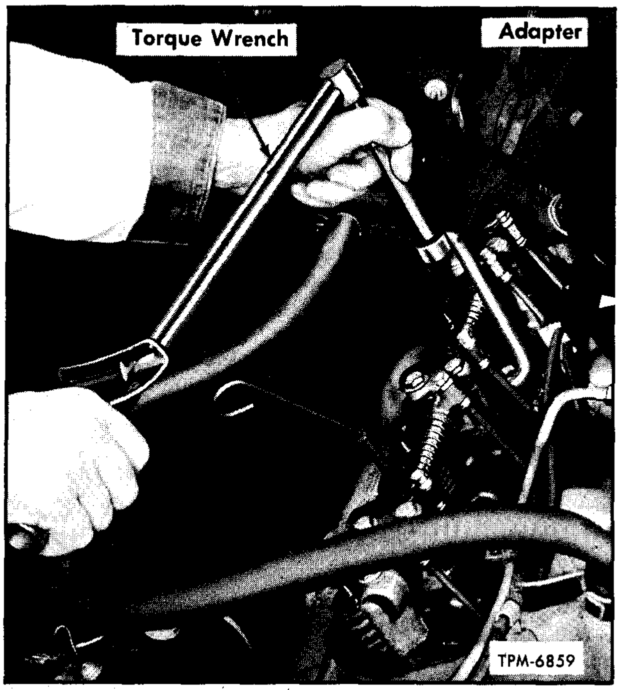


Figure 3—Use of Torque Wrench and Adapter to Tighten Cylinder Head Bolts

2. Check condition of wiring. If any wires are brittle, cracked, or otherwise damaged, replace as necessary.

3. Inspect distributor cap for burned wire sockets, cracks, and for erosion at terminals inside cap. Replace the distributor cap if it is not in good condition. When installing spark plug wires, refer to figure 2 which shows cylinder numbering, firing order, and distributor cap wire socket numbering.

4. Refer to ENGINE ELECTRICAL (SEC. 6Y) of this manual and inspect ignition distributor points, rotor, and advance mechanism. Make necessary parts replacement and/or adjustments.

BATTERY AND BATTERY CABLE SERVICE

1. Using battery hydrometer, check specific gravity of storage battery electrolyte in each cell. Gravity reading below 1.230 (corrected to 80°F.) indicates insufficient charge.

2. Use a voltmeter to check cranking voltage.

Disconnect coil primary lead from negative terminal on coil to prevent engine from firing during test.

3. With voltmeter connected between coil positive terminal and ground, operate starter. Voltage of 9 volts or more when starter is cranking engine indicates that battery and ignition circuit to coil are satisfactory. If voltage reading is less than 9 volts when engine is being cranked, or if cranking speed is low, a weak battery, defective starter

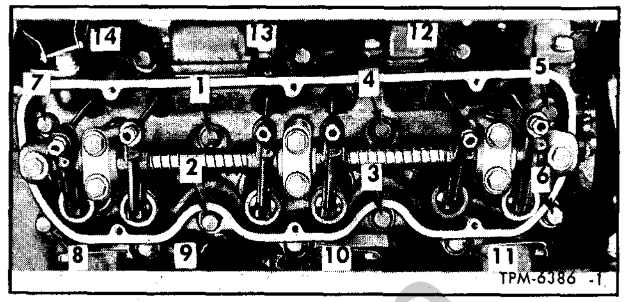


Figure 4—Cylinder Head Bolt Tightening Sequence on V6 Engine

switch, or excessive resistance in ignition circuit exists.

NOTE: If, when making check of cranking voltage, it is noted that cranking speed is uneven, this is indication of uneven compression, defective starter or starter drive.

4. In cases where loose, corroded, or otherwise defective battery cables and/or wiring are found, the defects must be corrected to insure good engine performance.

5. If battery is weak or shows other evidence of being defective, refer to appropriate coverage in ENGINE ELECTRICAL (SEC. 6Y) in this manual for method of diagnosing battery deficiencies.

CYLINDER HEAD BOLT TORQUE AND VALVE LASH ADJUSTMENT

A check of cylinder head bolt torque should be made at regular tune-up intervals, and should be followed by valve lash adjustment. Follow procedure given on next page to tighten cylinder head bolts and adjust valve lash.

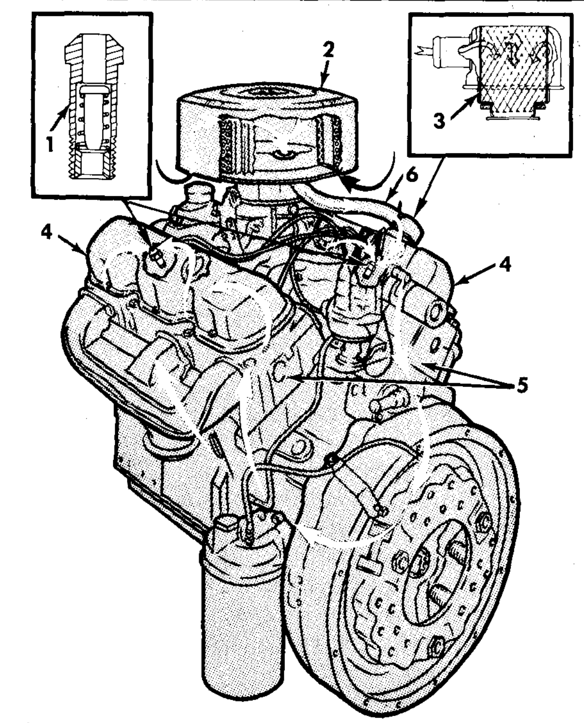
1. Run engine until normal operating temperature is reached, then stop engine and remove rocker arm covers.

2. Referring to figure 3 use torque wrench to tighten cylinder head bolts in sequence shown in figure 5. Correct head bolt torque is 60 to 65 foot-pounds on V6 engines.

3. Using feeler gauge and box end wrench, set exhaust valve clearance at 0.018-inch and intake valve clearance at 0.012-inch on V6 engine.

4. While performing above operations, observe the oil supply to valve rocker arms. If there appears to be insufficient lubrication, make necessary corrections to provide adequate oil supply.

NOTE: When rocker arm covers are removed, an inspection of crankcase ventilation valves should be made to determine if they are functioning properly. Refer to appropriate portion in "Crankcase Ventilation System" later in this section for instructions for servicing ventilation valves.



1 Crankcase Ventilation Valve Assembly
2 Carburetor Air Cleaner
3 Breather Cap
4 Rocker Arm Cover
5 Cylinder Heads
6 Ventilation Hose

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Figure 5—Schematic Arrangement of Crankcase Ventilation System Components

CHECKING GENERATOR AND CHARGING CIRCUIT

Refer to ENGINE ELECTRICAL (SEC. 6Y) in this manual for procedure required to check performance of charging circuit units and wiring.

COOLING SYSTEM INSPECTION

Refer to ENGINE COOLING SYSTEM (SEC. 6K) in this manual for arrangement of cooling system units and for inspection and required maintenance procedures.

CARBURETOR THROTTLE AND CHOKE LINKAGE

On most vehicles it will be necessary to remove air cleaner or air intake hose adapter at carburetor to observe choke operation and action of throttle linkage. All linkage must be maintained in free working condition and should be checked as part of tune-up procedure. Oil linkage pivot points if any binding is evident. Complete information on throttle linkage is given in ENGINE FUEL SYSTEM (SEC. 6M) in this manual.

CARBURETOR IDLE SPEED AND IDLE MIXTURE ADJUSTMENTS

Refer to ENGINE FUEL SYSTEM (SEC. 6M) in this manual for appropriate procedures for adjusting carburetors.

INSPECTING ELECTRICAL EQUIPMENT AND ENGINE PERFORMANCE WITH INSTRUMENTS

1. Hook up test equipment for use in making final adjustments. Equipment required consists of dwell meter, tachometer, vacuum gauge and timing light.

2. With engine running at idle speed, check dwell angle and readjust if necessary.

3. With vacuum line to distributor disconnected and plugged, run engine at idle speed and check ignition timing with timing light. Loosen distributor clamp and rotate distributor body to change timing as required. Tighten distributor clamp and connect vacuum line after checking timing.

4. While observing vacuum gauge and tachometer, set engine idle speed and adjust carburetor idle mixture screws to provide steady running engine. ENGINE FUEL SYSTEM (SEC. 6M) in this manual covers instructions for adjusting carburetors.

NOTE: If difficulty is experienced in obtaining satisfactory engine idle performance, the cause may be due to malfunction of crankcase ventilation valves. Inspection and service of ventilation valves are covered later under appropriate headings under "Crankcase Ventilation System."

5. Refer to ENGINE ELECTRICAL (SEC. 6Y) of this manual for instructions for checking voltage and current regulator settings, generator output, and specifications on electrical equipment units.

CRANKCASE VENTILATION SYSTEM

All engines have closed, positive type crankcase ventilation system. Fumes and vapors which would contaminate atmosphere are evacuated from crankcase and valve compartment through ventilation valves which regulate the flow of gases into intake valve ports in cylinder heads.

Figure 5 shows schematic arrangement of crankcase ventilation units for V6 engine.

Ventilation valves on V6 engines cannot be disassembled but can be removed with wrench for inspection. Figure 6 shows the design of valves for each type of engine.

If, when performing tune-up operations, the engine does not idle smoothly after all checking and adjusting is done, the crankcase ventilation valves may be cause of unsatisfactory performance at idle speed.

INSPECTION AND UNIT REPLACEMENT

1. Remove rocker arm cover from each cylinder head.

2. Make visual inspection of ventilation valves for accumulation of sludge or other matter at valve inlet (fig. 6).

3. If valves appear to be in good condition, start engine and allow to run at idle speed. Connect tachometer if vehicle is not so equipped.

4. Note tachometer reading, then cap the ventilation valve inlet openings and compare tachometer reading with reading previously noted with ventilation valve inlet openings open. If there is a change of less than 50 rpm when openings in ventilation valves are closed - a malfunction of one or more of the valves is indicated.

5. Remove valves from cylinder heads with socket wrench. Valves may be cleaned by washing in cleaning solvent. If the internal passage is blocked by hard deposits, a new valve assembly must be installed on V6 engines.

6. Remove hose from breather cap on rocker arm cover and check for obstructions in hose (6, fig. 5). Remove breather cap (3, fig. 5). Inspect breather cap and if it is clogged wash element in cleaning solvent, then reassemble parts.

IMPORTANT NOTE

The positive crankcase ventilation (P.C.V.) valve(s) MUST be replaced every 12 months, or at 12,000-mile intervals, whichever occurs first. Also, replace ventilation hoses and/or clamps if not in good condition.

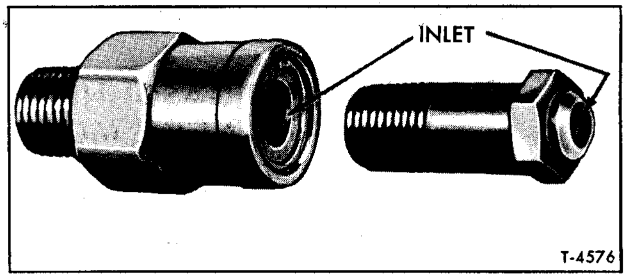


Figure 6—Crankcase Ventilation Valves

EXHAUST EMISSION CONTROL SYSTEMS

Vehicles built for use in States which have laws pertaining to control of air pollution by motor vehicle emissions, are equipped with devices necessary to comply with the law.

Refer to "Exhaust Emission Control System" included later in ENGINE FUEL SYSTEM (SEC. 6M) of this manual for information covering maintenance which is peculiar to the engines having exhaust emission controls.

Refer to Next Page For Gasoline Engine Tune-up Specifications.

GASOLINE ENGINE TUNE-UP SPECIFICATIONS

V6 GASOLINE ENGINE TUNE-UP CHART (ENGINE MODELS 401M AND 478M)

Specifications apply to all engines unless otherwise indicated.

TYPE AND NUMBER OF CYLINDERS	60°V-6
CYLINDER COMPRESSION (PSI)	125
SPARK PLUGS	
Spark Plug Make and No.	AC-CR-43N
Spark Plug Gap	0.035"
Spark Plug Tightening Torque (Ft.-Lbs.)	32
IGNITION DISTRIBUTOR	
Dwell Angle (Degrees)	31-34
Point Gap (New)	0.019"
Point Gap (Used)	0.016"
Contact Lever Spring Tension (Oz.)	19-23
FIRING ORDER	1-6-5-4-3-2
IGNITION TIMING (See NOTE below)	10° BUDC*
VALVE LASH	
Intake	0.012"
Exhaust	0.018"
ENGINE GOVERNOR SETTINGS (Full Load Rpm)**	
401M	3400
478M	3200
ENGINE IDLING SPEED (RPM)	500-550
FUEL PUMP PRESSURE (PSI)	5-6.5
CYLINDER HEAD BOLT TORQUE (FT.-LBS.)	60-65

NOTE: At engine idle speed with vacuum advance line disconnected and plugged.

*Recommended setting when using average nation-wide regular fuel. Timing must be retarded as required when lower octane fuel is used.

**No load speed is approximately 300 rpm higher than full load speed.

ENGINE REPLACEMENT

V6 ENGINE REPLACEMENT FOR CONVENTIONAL CAB MODELS

ENGINE REMOVAL

1. Drain radiator.
2. Disconnect battery.
3. Remove hood attaching parts and remove hood.
4. Remove grille and radiator braces.
5. Remove radiator and heater hoses.
6. Disconnect oil cooler lines from radiator (some engines do not have oil cooler).
7. Remove grille and radiator. Also remove front bumper.
8. Disconnect fuel supply line.
9. On vehicles with air compressor, disconnect air lines.
10. Disconnect engine ground strap.
11. Disconnect exhaust pipes from exhaust manifolds.
12. Disconnect accelerator and choke controls from carburetor.
13. Disconnect tachometer drive (when used).
14. If vehicle is equipped with power steering, the power steering pump may be removed from engine and fluid lines may remain connected during engine removal.
15. Disconnect clutch release linkage.

NOTE: The hydraulic clutch release cylinder line (when used) should remain attached to cylinder, the cylinder rod disconnected from release lever, and cylinder mounting bolts removed to permit engine removal without draining fluid from clutch release system.

16. Attach sling to overhead hoist to take weight off front mounting. Remove mounting bolt.
17. Remove clutch housing-to-flywheel housing bolts, then carefully work engine forward to disengage transmission drive gear from clutch driven member splines. When free from transmission, raise engine and remove from vehicle.

ENGINE INSTALLATION

Engine installation is accomplished by reversing "Engine Removal" procedure, meanwhile taking necessary precautions to maintain cleanliness and to avoid damaging components.

After engine is installed, check operation of control linkage. Fill cooling system and check for leaks.

Fill crankcase with engine oil of recommended grade and viscosity.

Start engine, make adjustments at carburetor, set ignition timing, and adjust valve lash.

NOTE: If engine has been run in on test stand, the foregoing adjustments will have been made previously and need not be repeated.

V6 REPLACEMENT FOR TILT CAB MODELS

GENERAL

The steps required to replace an engine in tilt-cab models with gasoline engine will vary with the models and optional equipment involved. Procedure which follows will serve as a guide for use when engine replacement is necessary. In most instances the engine and transmission should be removed as an assembly.

REMOVAL

1. Drain radiator and disconnect battery.
2. Disconnect oil cooler lines (when used). Cooler lines are attached to fittings at bottom tank on radiator. Oil will drain from lines and cooler when lines are disconnected.
3. Disconnect electrical wiring and cables at starter; also, disconnect engine ground strap.
4. Disconnect throttle and choke controls.
5. Disconnect transmission control rods, detach hoses from surge tank. Remove air cleaners and inlet hoses as necessary to permit removal of control island assembly. Disconnect front shock absorbers at upper bracket attached to cab rear support. Also remove power steering reservoir (when used).
6. Remove cab check link release rod guide from cab rear support. Remove control island, and cab rear support.
7. Disconnect exhaust pipes from manifolds.
8. Disconnect clutch control cylinder from release lever and flywheel housing. The fluid line may remain attached to cylinder to prevent fluid from draining from clutch control system while engine is removed.
9. Disconnect parking brake control (except when air-operated brake is used) and speedometer drive at rear of transmission.
10. Disconnect cooling system and heater hoses.
11. Disconnect propeller shaft from transmission.
12. If air compressor is used, disconnect air lines from compressor and remove compressor assembly. In some cases the air compressor mounting bracket may be detached from engine and compressor may remain with chassis when engine is removed.
13. If power steering is used, the power steering pump may be detached from engine and lines may remain connected to prevent fluid loss when removing engine.
14. Attach overhead hoist securely to engine sling, then raise power plant slightly to remove weight from engine mountings. Remove mounting bolts from front and rear mountings, then raise power plant and remove from chassis. Use care to prevent damage to fan blades as engine is raised.
15. Refer to applicable procedures in TRANSMISSIONS AND CLUTCHES (SEC. 7) of this manual for instructions, and remove transmission and clutch from engine.

INSTALLATION

Assemble clutch components and transmission to engine, referring to applicable instructions in TRANSMISSIONS AND CLUTCHES (SEC. 7) in this manual.

Install power plant by reversing order of "Engine Removal" procedure, taking necessary precautions to maintain cleanliness and to avoid damage to the engine components.

After engine is installed, check operation of control linkage, fill cooling system and check for leaks.

Fill crankcase with engine oil of recommended grade and viscosity.

Start engine, make adjustments at carburetor, set ignition timing and adjust valve lash.

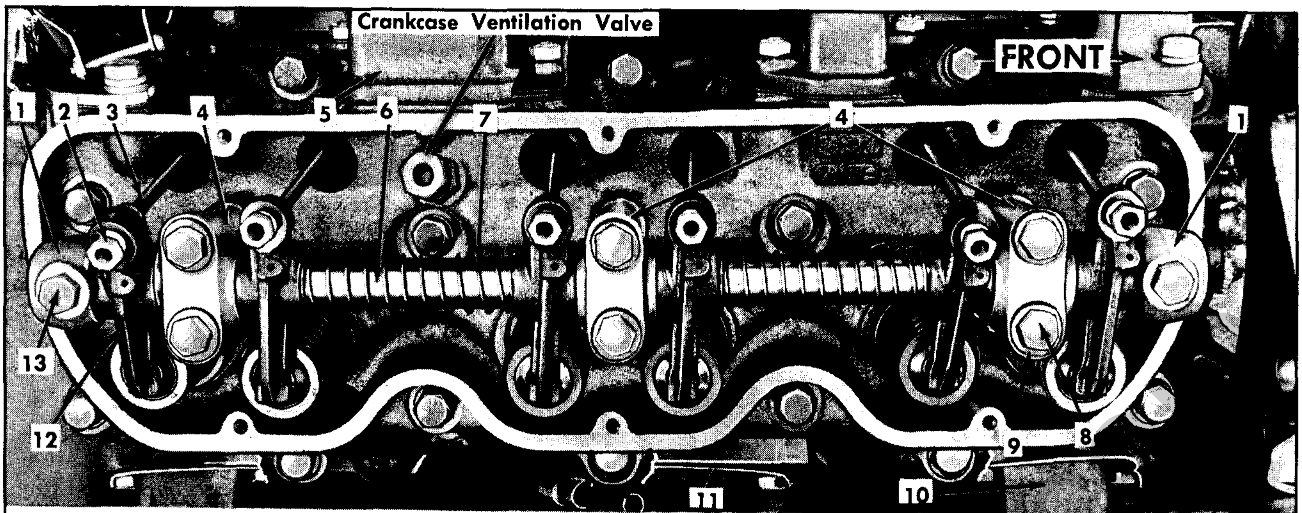
NOTE: If engine has been run in on test stand, the foregoing adjustments will have been made previously and need not be repeated.

IN-VEHICLE SERVICE OPERATIONS

VALVE OPERATING MECHANISM REPLACEMENT

The valve lifters cannot be removed until cylinder heads have first been removed.

Same instructions apply to either the right-hand or left-hand cylinder head.



1 End Bracket
2 Adjusting Screw
3 Push Rod
4 Rocker Arm Shaft Bracket
5 Intake Manifold
6 Rocker Arm Shaft
7 Spring
8 Bracket Bolt
9 Flat Washer
10 Exhaust Manifold
11 Exhaust Manifold Bolt Lock
12 Rocker Arm
13 Special Bolt

TPM-9875

Figure 7 —Valve Rocker Arms and Shaft Assembly Installed on V6 Engine

VALVE ROCKER ARM COVER REPLACEMENT

REMOVAL

Remove valve rocker arm cover screws, then remove rocker arm cover. On tilt cab models, it will be necessary to remove transmission shift rods in order to remove cover from left-hand cylinder head.

NOTE: If cover is stuck in place, loosen by striking with palm of hand or a rubber mallet. Do not pry on cover flange since the flange may be distorted.

INSTALLATION

Using new rocker arm cover gasket, install rocker arm cover and tighten cover screws uniformly.

ROCKER ARM AND SHAFT ASSEMBLY REPLACEMENT

REMOVAL

1. Remove rocker arm covers, referring to instructions previously given.

2. Loosen rocker arm shaft bracket bolts gradually until spring pressure is fully relieved at rocker arms. Lift off the rocker arm shaft and brackets, with attaching bolts, as an assembly.

3. Remove push rods and identify in some manner so they can be returned to original position at assembly.

INSTALLATION

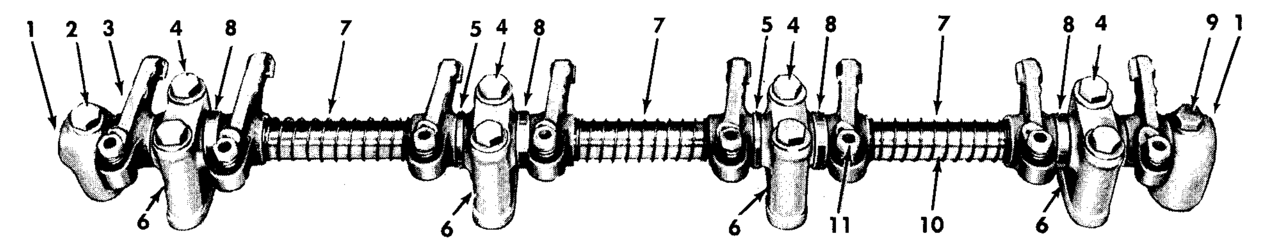
1. Place push rods in original positions, then place rocker arm shaft and bracket assembly (fig. 7) on cylinder head, being careful to engage rocker arm screws with sockets in push rods. Tighten bracket bolts to 25 foot-pounds torque.

2. Check clearance between rocker arm end brackets and adjacent rocker arm. If a clearance of approximately 0.030 inch does not exist, loosen end bracket bolts and relocate brackets as allowed by clearance in bracket hole, then tighten bolts to specified torque.

3. Make initial adjustment to provide clearance of 0.014 inch at intake valves, and 0.022 inch at exhaust valves.

4. Lubricate rocker arms with engine oil.

5. Install rocker arm covers temporarily while engine is run to warm up to operating temperature. With engine idling and temperature at 160°, adjust valve lash. Set exhaust valve clearance at 0.18 inch. On V6 engines lash intake valves to 0.012 inch. After valve clearance adjustment is made, install rocker arm cover using new gasket.



1 End Bracket
2 End Bracket Bolt and Plain Washer
3 Rocker Arm
4 Bracket Bolt and Plain Washer
5 Rocker Arm Spacer
6 Shaft Bracket
7 Spring
8 Thick Spacer
9 Special Bolt and Plain Washer
10 Rocker Arm Shaft
11 Adjusting Screw

T-4343-1

Figure 8—Rocker Arm Shaft and Brackets for V8 Engine

VALVE SPRING REPLACEMENT (V6 CYLINDER HEAD)

In most vehicles it is possible to replace a broken valve spring without removing cylinder head by following the procedure outlined below:

When it is necessary to replace a valve spring and/or seals on valve stems, the special tools shown in figure 13 may be used to facilitate the operation without removing the cylinder head. Proceed in following manner to replace valve spring and retaining parts.

1. Remove valve rocker arm cover.
2. Remove spark plug from cylinder on which work is to be done. Use spark plug gasket and install adapter (J-21546) in spark plug hole.
3. Remove the rocker arm shaft and bracket assembly from cylinder head. Install a 3/8-16 stud in bracket bolt hole adjacent to the valve spring to be removed. Stud must have sufficient threads to permit screwing stud nut down one-half inch after compressor contacts valve spring cap.
4. Turn engine crankshaft to place piston at BOTTOM of stroke. Attach compressed air supply line to adapter and turn on air supply. Air pressure in cylinder will hold valves against seats while spring and retaining parts are removed.
5. Assemble spring compressor (J-21544) and nut on stud as shown in figure 9, then with wrench, turn nut to force compressor down against valve spring cap meanwhile striking spring cap

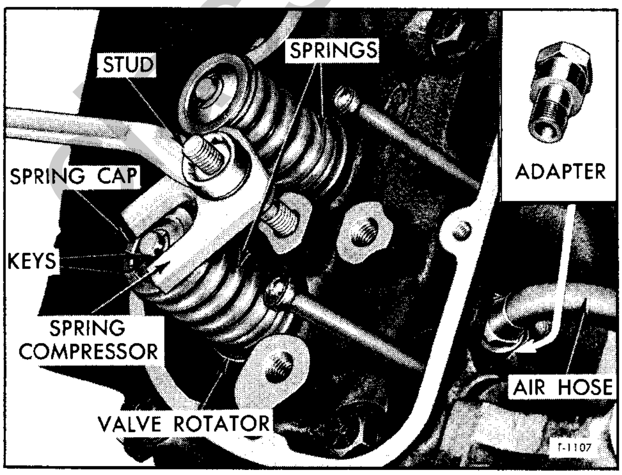
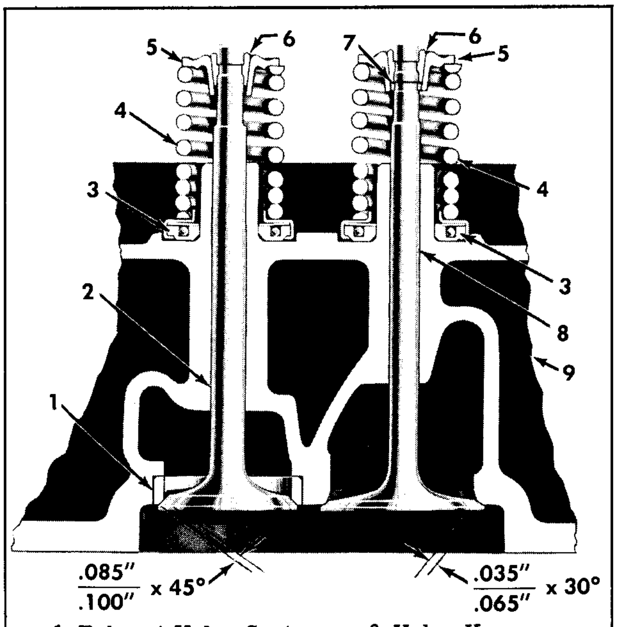


Figure 9—Use of Special Tool for Replacing Valve Spring without Removing Cylinder Head



1 Exhaust Valve Seat Ring
2 Exhaust Valve
3 Valve Rotator
4 Valve Spring
5 Valve Spring Cap
6 Valve Key
7 Oil Seal
8 Intake Valve
9 Cylinder Head

TPM-8424

Figure 10—Sectional View of V6 Engine Cylinder Head Assembly

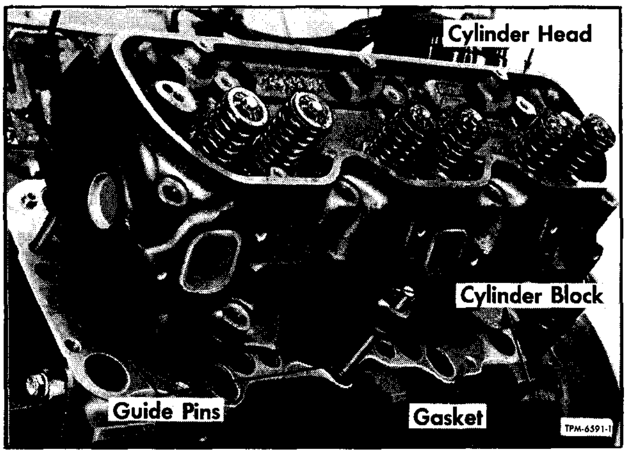


Figure 11—Installing Cylinder Head on V6 Engine

lightly with hammer to unseat the valve locking keys. Continue to turn the stud nut until spring is compressed sufficiently to permit removal of the two valve keys. Remove keys, then turn stud nut counterclockwise to release the valve spring. Swing the compressor away from valve, and remove the spring and seat. Remove oil seal whenever spring is removed from intake valve. Refer to figure 10 for valve spring and retaining parts installation.

CAUTION: DO NOT turn off the air supply while spring and retaining parts are removed from valve, as the valve may fall out of guide and drop into cylinder.

6. If valve rotator is replaced, be sure to position rotator on cylinder head with spring pilot on top. Set valve spring on rotator with close-wound coils toward cylinder head. Place spring cap on spring and use compressor in same manner as shown in figure 9 to compress valve spring. On intake valves, install new oil seal in lower groove in valve stem. Insert two keys in valve stem grooves, then back off stud nut to release pressure on valve spring. Be sure keys engage groove in valve stem. Remove compressor, stud, and nut from cylinder head.

7. Turn off air supply, and disconnect air line from adapter. Remove adapter and install spark plug and gasket. Tighten spark plug to 32 foot-pounds torque.

8. Install rocker arm shaft and bracket assembly and tighten bracket bolts evenly to 25 foot-pounds torque.

Refer to "Valve Operating Mechanism Replacement" for additional information regarding rocker arm shaft and bracket installation.

9. Start engine and when normal operating temperature is reached, check valve lash. Clearance should be 0.012 inch at intake valves and 0.018 inch at exhaust valves.

10. Install valve rocker arm cover and gasket.

MANIFOLD REPLACEMENT

EXHAUST MANIFOLDS (ALL ENGINES)

1. Disconnect exhaust pipe from exhaust manifold.

2. Bend locks away from manifold attaching bolts, then remove bolts. Figure 7 shows exhaust manifolds and attaching parts.

3. Remove manifolds and gaskets.

4. When installing exhaust manifolds, use new gaskets and bolt locks, tighten manifold bolts to 20 foot-pounds torque and secure bolts with lock tabs.

INTAKE MANIFOLD (V6 ENGINE)

1. Remove air cleaner or adapter and hoses from carburetor.

2. Disconnect throttle and choke controls from carburetor. Also disconnect vacuum line and hydraulic governor line.

3. Disconnect fuel line, then remove carburetor from manifold.

4. Remove manifold bolts with attached spark plug wire supports, and disconnect wires from spark plugs.

5. Remove remaining bolts attaching intake manifold to cylinder heads, then remove intake manifold and gaskets.

6. When installing intake manifold use new gaskets and reverse removal procedure described above. Correct intake manifold bolt torque is given in "Torque Wrench Specifications."

NOTE: After engine has been started and warmed up to normal operating temperature recheck manifold bolt torque to assure sufficient torque to prevent air leakage at manifold gaskets.

WATER MANIFOLD (V6 ENGINES)

The outlet manifold assembly is installed between the cylinder heads at front of engine and contains engine thermostats. Tapped holes are provided for heater hose connections and temperature gauge sending unit.

1. Drain cooling system to a point below cylinder heads.

2. Disconnect radiator hose from water outlet housing.

3. Remove manifold-to-cylinder head bolts, then remove the water manifold and gaskets.

NOTE: Refer to ENGINE COOLING SYSTEM (SEC. 6K) in this manual for instructions for inspecting and replacing thermostats.

4. When installing water outlet manifold use new gaskets and tighten bolts to 20 to 25 foot-pounds torque.

5. After radiator hose is connected, and sending unit installed, fill cooling system and inspect for leaks.

CYLINDER HEAD AND GASKET REPLACEMENT

To replace either cylinder head and/or gasket on gasoline engines follow the instructions as outlined in paragraphs following. On rear-engine school buses, unless special provisions are made in the vehicle body design, it will be necessary to remove engine from chassis to gain sufficient working space to remove cylinder heads. The shield attached to rear of cab support on Tilt-Cab models should be removed to provide access to rear head bolts.

CYLINDER HEAD REMOVAL

NOTE: When left-hand head is to be removed from tilt cab model, the transmission control rods must first be removed.

1. Drain cooling system.
2. Disconnect exhaust pipe from exhaust manifold, then remove exhaust manifold and gasket.
3. Remove valve cover, rocker arms and push rods. Identify push rods so they can be returned to original positions when installed. Procedures for replacing valve rocker arms and rocker arm covers are given previously under respective headings.
4. Disengage spark plug wires from plugs and from plug wire supports.
5. On V6 engines, remove water outlet manifold as previously instructed under "Manifold Replacement."

NOTE: If only one cylinder head is to be removed, the intake manifold (and water outlet manifold on V6 engines) may remain in place on opposite head, in which case carburetor controls and fuel line need not be disconnected. However, it will be necessary to loosen the manifold attaching parts to permit cylinder head to rise off locating dowels.

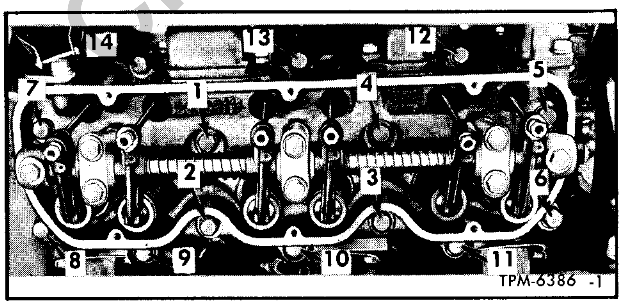


Figure 12—Cylinder Head Bolt Tightening Sequence on V6 Engine

6. Remove cylinder head bolts.
7. Lift cylinder head off cylinder block, then remove head gasket, and clean carbon deposits from cylinder head, pistons, and cylinder block.

CYLINDER HEAD INSTALLATION

NOTE: If valve lifters have been removed, lubricate lifters with special break-in compound and install in respective bores.

1. Check gasket surface on cylinder head and on cylinder block. Surfaces must be clean. Place cylinder head gasket on top of cylinder block with word "TOP" facing upwards. Dowels will locate gasket. If available, guide pins (fig. 11) may be temporarily installed in two cylinder head bolt holes to locate head as it is lowered into place.
2. Set cylinder head in place on gasket with dowels in block engaged with mating holes in cylinder head. Apply S.A.E. #10 engine oil on threads and heads of cylinder head bolts, then install cylinder head bolts and draw head down gradually. Finally tighten cylinder head bolts in sequence shown in figure 19 on V6 engines, or as shown in figure 20 on V8 engines. Tighten bolts gradually to final torque of 60 to 65 foot-pounds on V6 engines.
3. Install one crankcase ventilation valve in each head on V6 engines.
4. Install exhaust manifolds using new gaskets and bolt locks. Tighten exhaust manifold bolts to 15 to 20 foot-pounds torque. Connect exhaust pipes to manifolds.
5. Use new intake manifold gaskets between intake manifold and cylinder heads, and bolt intake manifold (and water outlet manifold on V6 engines) in place, tightening manifold bolts evenly to seat parts squarely at gaskets. Correct intake manifold torque is 20 to 25 foot-pounds torque.
6. Lubricate push rods, and position at valve lifters in original locations. Set valve rocker arm assembly on cylinder head and bolt in place following instructions previously given under "Valve Operating Mechanism Replacement."
7. Install valve rocker arm cover, using new gasket.
8. Connect spark plug wires, fill cooling system; then start and run engine until thoroughly warmed up (160°). Use torque wrench and adapter (fig. 4) to final tighten cylinder head bolts. Check intake manifold bolt torque. "Torque Wrench Specifications Chart" is at end of this section.
9. Adjust valve lash to specifications listed in appropriate "Tune-Up Chart" on page 6A-8.

CRANKSHAFT PULLEY AND HUB REPLACEMENT

On some models the crankshaft pulley is not readily accessible unless the radiator core is first removed. The special tool typically illustrated in figure 13 must be used to start the pulley retaining cone off crankshaft.

REMOVAL

1. Remove radiator if necessary, to provide access to crankshaft pulley. On engines with fan blades installed on crankshaft pulley, remove fan blades from crankshaft pulley hub. Also remove accessory drive belts.

2. Use impact wrench, or hold engine flywheel and use conventional wrench to remove pulley retaining bolt.

3. Assemble puller and center plug in manner shown in figure 13, then turn puller screw to remove pulley or hub from crankshaft.

INSTALLATION

1. Clean seal area on crankshaft pulley or hub thoroughly and apply engine oil on surface contacted by oil seal. Seal must roll into damper hub counterbore as damper is installed.

2. Align keyway in pulley with key in crankshaft, then start pulley or hub onto front end of crankshaft. Assemble special installer shown in figure 14, and turn nut with wrench to force pulley firmly into place on crankshaft.

3. Remove installer, then referring to figure 15, locate cone at hub on 478M engines. Install retaining washer and bolt. When phosphate coated bolt is used, tighten bolt to 180-200 foot-pounds torque. If cadmium plated bolt is used, correct torque is 240 to 260 foot-pounds.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

REMOVAL

1. Remove crankshaft pulley or hub as previously instructed under "Crankshaft Pulley and Hub Replacement."

2. Use suitable tool to pry oil seal out of front cover.

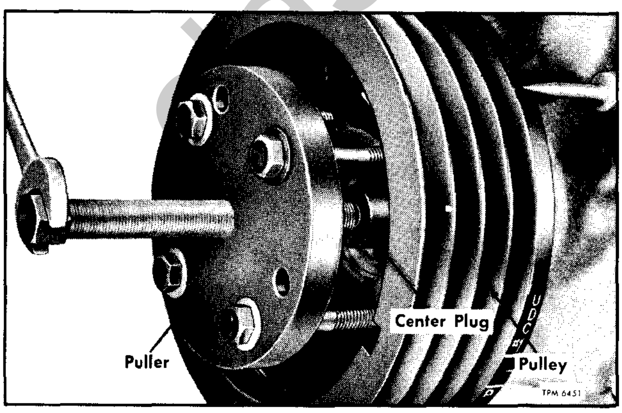
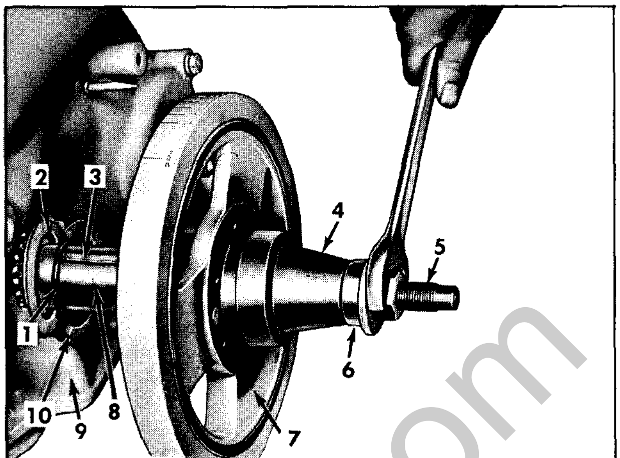


Figure 13—Crankshaft Pulley Removal (Typical)



1 Seal "O" Ring
2 Slinger
3 Key
4 Installer
5 Installer Screw
6 Thrust Bearing
7 Crankshaft Damper
8 Crankshaft
9 Engine Front Cover
10 Oil Seal

T-2172-2

Figure 14—Installing Damper Assembly on Crankshaft with Special Tool Set

INSTALLATION

A special tool (J-7879-10) is available for installing crankshaft front oil seal assembly without removing front cover.

1. Lubricate oil seal lip with engine oil, then turn engine crankshaft so key (3, fig. 14) is at top as shown.

2. Locate new seal assembly at bore in front cover with seal lip pointing inward, then assemble special tool components as shown in figure 16.

3. Tighten nut against thrust bearing to force seal squarely into cover bore.

4. Inspect surface on pulley hub, with magnifying glass if necessary, to locate any nicks, burrs, or scratches which could cause rapid wear at oil

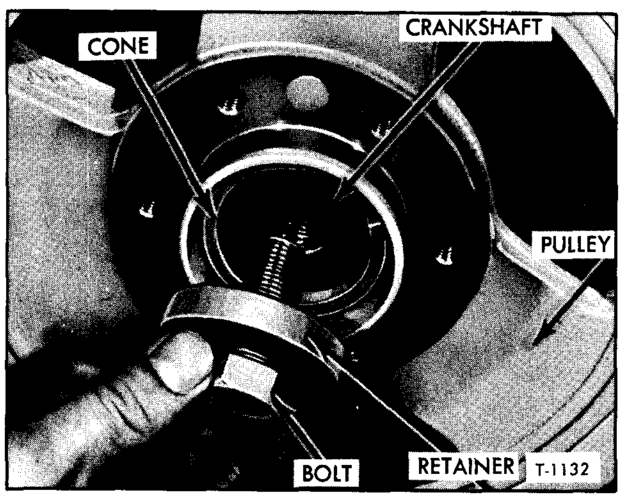


Figure 15—Crankshaft Hub Retaining Parts (Typical)

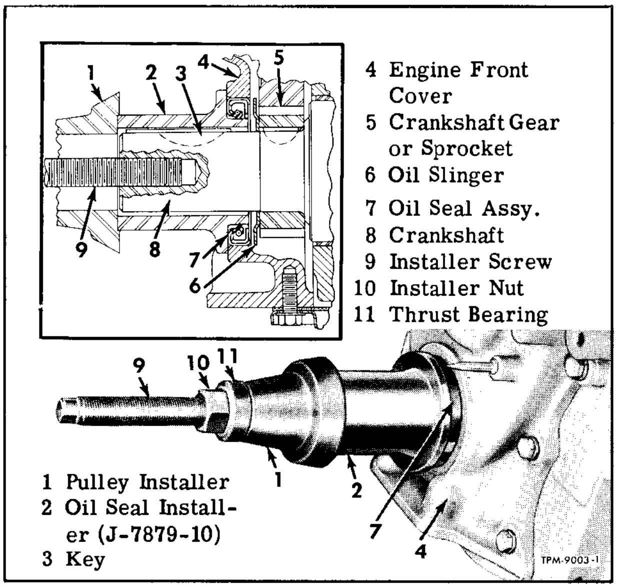


Figure 16—Front Cover Oil Seal Installation (with Cover Installed on Engine)

seal. When inspection shows surface to be in poor condition, install a new damper assembly or pulley hub.

5. Install crankshaft pulley or hub following instructions previously given under "Crankshaft Pulley and Hub Replacement."

ENGINE OIL PAN REPLACEMENT (V6 ENGINE)

OIL PAN REMOVAL

1. Clean all dirt and accumulated material from oil pan attaching bolts and drain plug.
2. Drain oil from oil pan.
3. Remove oil pan bolts and stud nut, then remove oil pan. Scrape off any portions of gasket which adhere to oil pan flange or to bolting flange on cylinder block and engine front cover.

OIL PAN INSTALLATION

1. Use gasket cement to hold new oil pan gasket in place at cylinder block and front cover.
2. Position oil pan at engine and install attaching bolts and stud nut.

NOTE: Three of the oil pan bolts are longer than the others, and these must be installed at rear of oil pan at reinforcement. These bolts may be readily identified by internal-external type lock washers. Other pan bolts are shorter.

3. Install drain plug with new gasket, then fill crankcase with engine oil to "FULL" mark on dip stick.

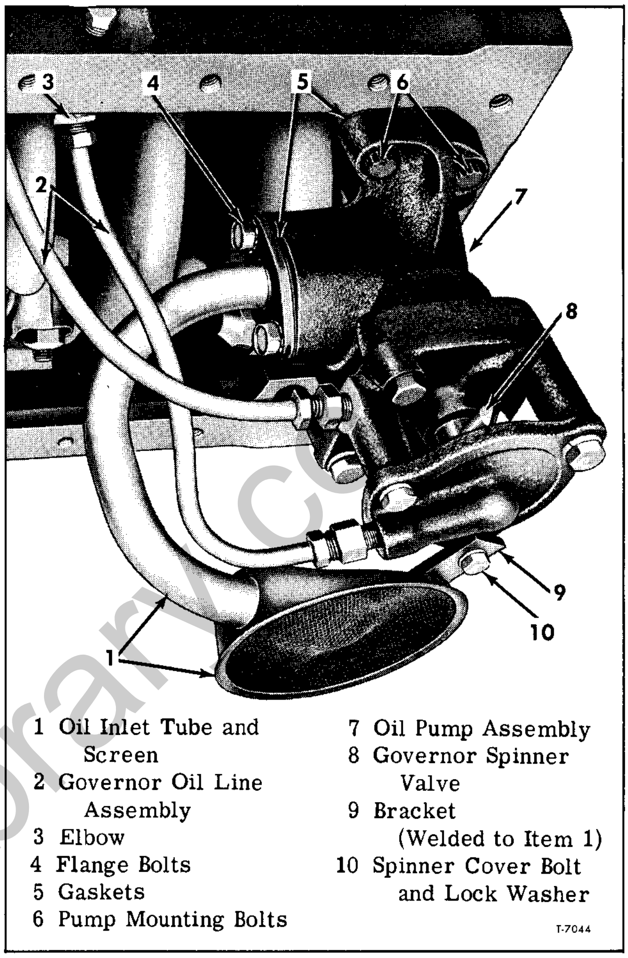


Figure 17—Engine Oil Pump and Governor Spinner Valve Assembly Installed (V6 Engine)

ENGINE OIL PUMP REPLACEMENT (V6 ENGINE)

(Refer to Figure 17)

REMOVAL

1. Remove engine oil pan as previously directed under "Engine Oil Pan Replacement."
2. Remove the hydraulic governor oil line assembly.
3. Remove two special pump mounting bolts, then remove engine oil pump with oil inlet tube and screen assembly attached. Oil pump drive shaft will usually remain in socket in oil pump shaft.

INSPECTION AND REPLACEMENT OF SUCTION TUBE AND SCREEN

Inspect screen and tube for damage. If screen is clogged, the assembly should be removed from pump and thoroughly cleaned; or a new suction tube and screen assembly installed.

When installing tube and screen assembly on oil pump, use new gasket between tube flange and

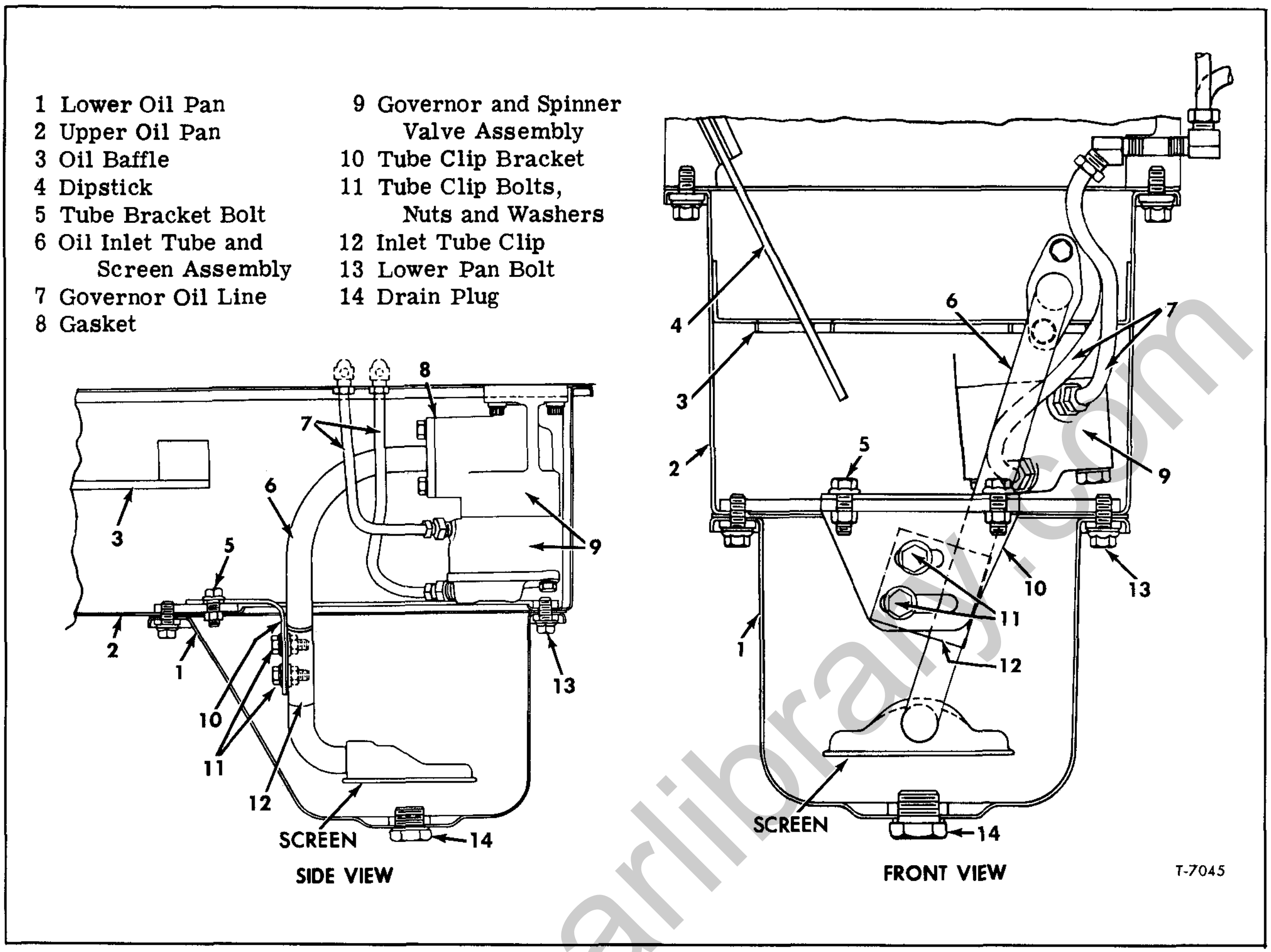


Figure 18—Oil Pan, Oil Pump, and Inlet Screen Installation (V8 Engine)

pump body. Install all attaching bolts loosely, then tighten bracket bolt first. Correct torque is 20 to 25 foot-pounds. Finally, tighten tube flange bolts. Figure 17 shows engine oil pump without hydraulic governor spinner valve.

INSTALLATION

1. Place new pump-to-block gasket on oil pump flange, and insert pump drive shaft in drive socket in pump shaft.
2. Set oil pump assembly in position at cylinder block and turn pump as necessary to engage pump drive shaft with drive socket at upper end.
3. Position the hydraulic governor line (2, fig. 17) at fittings on cylinder block and oil pump and start oil line nuts.
4. Install oil pump-to-cylinder block bolts and tighten to 30 to 35 foot-pounds torque. Tighten hydraulic governor oil line nuts.
5. Install engine oil pan, following instructions previously given in "Engine Oil Pan Replacement."

NOTE: Use gasket cement to hold the oil pan

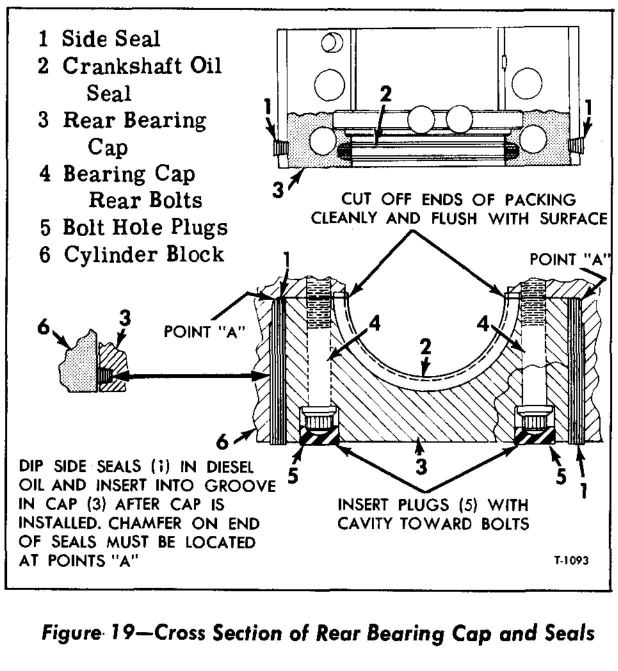


Figure 19—Cross Section of Rear Bearing Cap and Seals

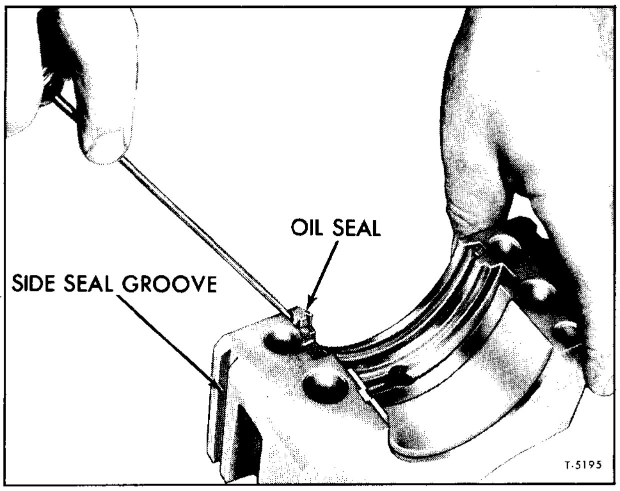


Figure 20—Removing Seal Lower Half from Bearing Cap

gasket in place at cylinder block and front cover. Tighten bolts evenly to 10 to 15 foot-pounds torque. Overtightening the bolts will distort the oil pan flange.

2. Use new gasket and mount oil inlet tube and screen assembly on oil pump body. Clip the inlet tube to bracket (10), tighten the clip bolts to 20 to 25 foot-pounds torque. Bolts attaching bracket (10) to upper oil pan should also be tightened to 20 to 25 foot-pounds torque.

3. Install lower oil pan (1) using new gasket and bolts which have threads coated with sealer to prevent oil leaks. Correct torque on lower pan bolts is 6 to 8 foot-pounds.

4. Install drain plug with new gasket, then fill crankcase with engine oil to "FULL" mark on dip stick. Use oil as specified in LUBRICATION (SEC. 0) in this manual.

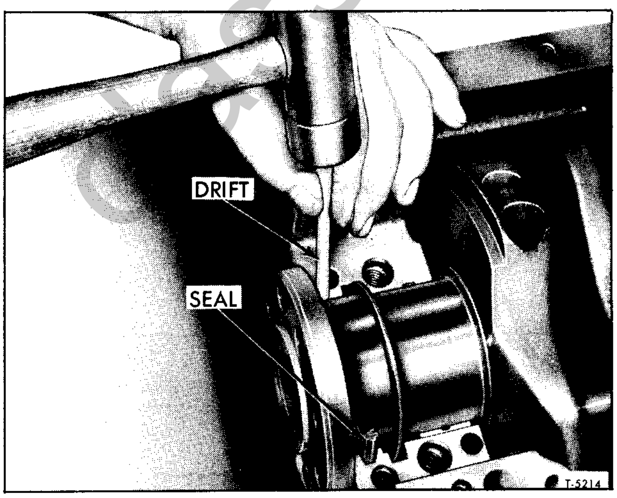


Figure 21—Removing Seal Upper Half from Block

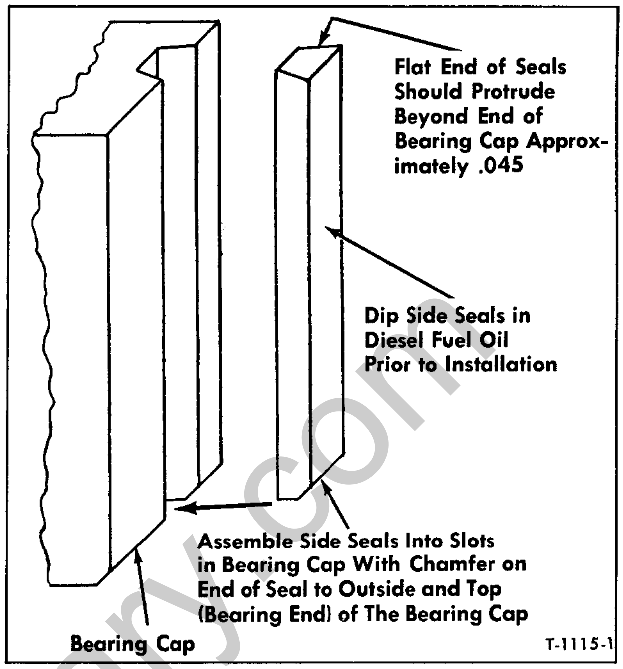


Figure 22—Bearing Cap Side Seal Installation

TACHOMETER DRIVE ADAPTER REPLACEMENT

REMOVAL (Fig. 23)

1. Remove floor pan from cab on conventional cab models, or remove shield from cab rear support on tilt cab models.

2. Disconnect tachometer drive shaft housing (1) from adapter (3).

3. Remove two bolts and lock washers (4) attaching adapter (3) to cylinder block.

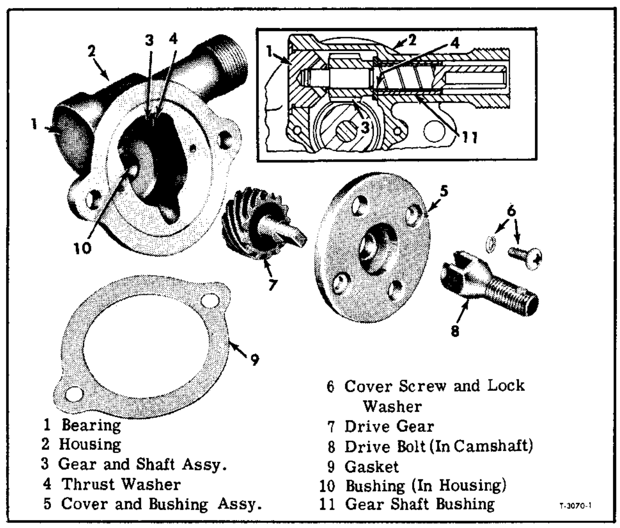
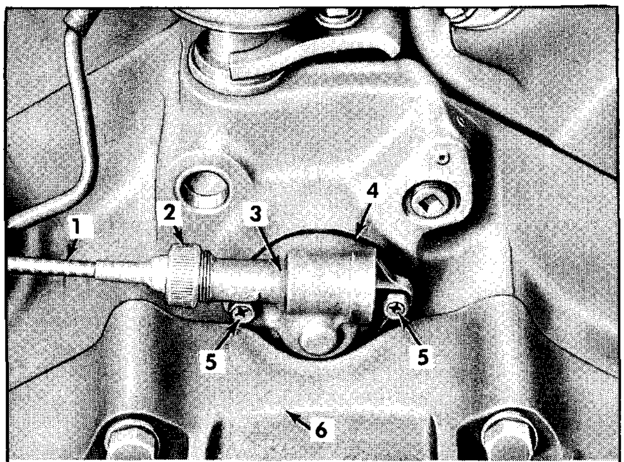


Figure 23—Tachometer Mechanical Drive Components



1 Drive Housing
2 Housing Nut
3 Tachometer Adapter
4 Gasket
5 Adapter Mounting Bolt
6 Flywheel Housing

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Figure 24—Tachometer Drive Installed

4. Remove adapter assembly and gasket from cylinder block.

NOTE: If difficulty is experienced in removing the adapter assembly, try turning over engine with starter to turn bolt (8, fig. 23) so drive slot is in vertical position to permit disengagement of drive shaft (7, fig. 23).

5. Referring to figure 23, remove cover (5) and inspect teeth on gears (3 and 7). Clean oil holes in cover.

INSTALLATION

1. Lubricate adapter parts with clean engine oil and attach cover to housing with screws and lock washers (6, fig. 23).

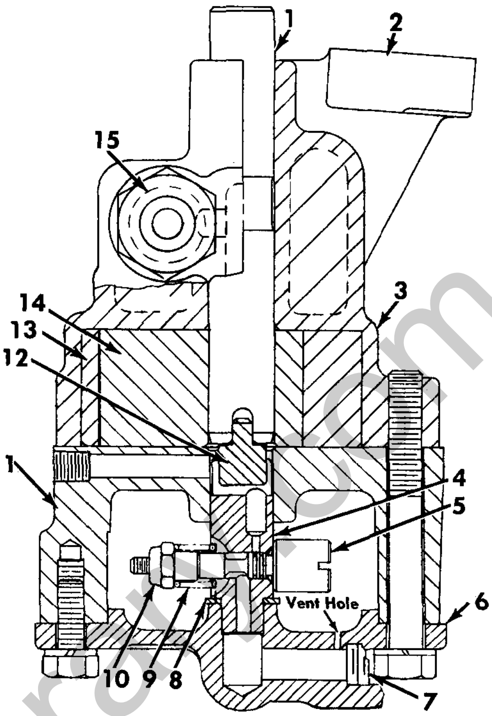
2. Check drive bolt (8, fig. 23) to make sure it is firmly tightened into threads in camshaft. If necessary, turn engine crankshaft to position drive bolt slot in vertical position.

3. Align tongue on adapter shaft with drive bolt slot, then place new gasket at cylinder block and install adapter assembly. Connect flexible drive shaft housing to adapter (fig. 24).

4. Check tachometer drive cable and housing routing. There must be no sharp bends or kinks in the assembly. Lubricate tachometer drive cable with approved lubricant (Type ST-640) or equivalent.

HYDRAULIC GOVERNOR TROUBLESHOOTING

To check for proper performance of hydraulic governor units the following procedure may be used:



1 Shaft and Inner Rotor Assembly
2 Pump Outlet
3 Pump Body
4 Governor Spinner Shaft
5 Governor Spinner Valve
6 Governor Spinner Cover
7 Governor Pressure Outlet
8 Shaft Thrust Washer
9 Valve Spring
10 Valve Adjusting Nut
11 Rotor Cover and Spinner Housing
12 Drive Coupling
13 Outer Rotor
14 Inner Rotor
15 Oil Pump Pressure Relief Valve Spring Cap

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Figure 25—Sectional View of Oil Pump and Governor Spinner Valve Assembly

1. Warm up engine to normal operating temperature (approx. 180°F.).

2. Install a tee in governor line at carburetor and attach pressure gauge. Provide a tachometer to check engine speed.

3. Start engine and momentarily run engine at full throttle to check no-load rpm and oil pressure on gauge. Chart below shows correct full load rpm and oil pressure in governor line for each type of engine:

Engine Model	Full-Load Governed Rpm	Gauge Oil Pressure
401M	3400	8-10 psi
478M	3200	8-10 psi

NOTE: No-load speeds will be approximately 300 rpm higher than indicated full-load speeds.

NOTE: If the oil pressure does not check to the above specifications, this would indicate that the governor spinner assembly should be replaced or adjusted as instructed under "Governor Spinner Valve Adjustment" later in this manual.

If oil pressures do check with the above specifications and governor still does not operate properly, the slave unit at carburetor should be checked or replaced.

GOVERNOR SPINNER VALVE ADJUSTMENT

If governed speed on engines equipped with hydraulic type governor is not as specified in applicable "Gasoline Engine Tune-up Chart" the speed can be changed by adjusting spinner valve spring tension.

To change the engine governor speed, proceed as follows:

1. Drain oil from oil pan and remove oil pan from engine.
2. Turn engine crankshaft as necessary to position the spinner valve weight and adjusting nut so wrench and screwdriver can be used to make adjustment.
3. To change engine rpm, hold weight with screwdriver while turning nut (10, fig. 25). Tightening nut 1/8 turn increases engine speed approximately 100 rpm. Loosening nut 1/8 turn lowers engine governed speed approximately 100 rpm.
4. After adjusting the governor, install oil pan with enough screws to hold pan in place while rechecking governed speed. Be sure to add engine oil to mark on dipstick. With oil warmed up, recheck no-load speed.
5. When governor performance is satisfactory, install balance of oil pan screws and tighten evenly and firmly.

CHECKING ENGINE VALVE TIMING

When a check of valve timing is necessary, the following procedure may be used referring to markings at crankshaft pulley hub or pulley for determining upper-dead-center on No. 1 cylinder:

1. Remove left-hand rocker cover from cylinder head to provide access to rocker arms at No. 1 cylinder.
2. Turn engine clockwise (viewed from front of engine) to UDC #1 mark at crankshaft pulley on compression stroke. Both the intake and the exhaust valve on No. 1 cylinder will then be closed.
3. On all V6 engines adjust clearance to exactly 0.099 inch at No. 1 exhaust valve (front valve). On V8 engine, to check valve timing, set No. 1 exhaust valve clearance to 0.059 inch.
4. Turn engine clockwise until No. 1 exhaust valve opens and begins to close, then with fingers, try turning push rod of No. 1 exhaust valve as engine is cranked slowly. When push rod rotates with finger pressure, the 5-degree (BUDC) mark on pulley should be at pointer. This will be about one revolution from starting point. If push rod starts to rotate at any point between 10 degree mark and UDC #1 mark, the valve timing is correct. Be sure to adjust exhaust valve clearance to 0.018 inch after performing the foregoing check.

NOTE: A mismatched gear tooth can be recognized by the following error in timing mark position when following the above procedure:

401M and 478M . . . . 12°

TORQUE WRENCH SPECIFICATIONS

(Torque Wrench Specifications Listed Apply to Clean, Dry Threads Unless Otherwise Indicated)

Item	Ft.-Lbs.
Cylinder Head Bolts	
V6 Engines	60-65*
Intake Manifold Bolts (V6 Eng.)	20-25
Intake Manifold Bolts (V8 Eng.)	25-30
Exhaust Manifold Bolts	15-20
Water Outlet Manifold Bolts (V6 Eng.)	20-25
Oil Filter Stud	40-50

Item	Ft.-Lbs.
Oil Filter By-Pass Valve Plug	35-40
Spark Plugs	30-34
Rocker Arm Shaft Bracket Bolts	20-25
Damper or Hub-to-Crankshaft Bolt	
Phosphate Coated Bolt	180-200
Cadmium Plated Bolt	240-260
Oil Pan Drain Plug	20-25
Oil Pump to Block Bolts	30-35

*Oiled with S.A.E. No. 10 Engine Oil.

Refer to pages following for Trouble Diagnosis Chart.

TROUBLE DIAGNOSIS CHART

HARD STARTING

SYMPTOM A - SLOW CRANKING

POSSIBLE CAUSES	REMEDY
1. Heavy engine oil.	1. Change to lighter oil.
2. Partially discharged battery.	2. Charge battery.
3. Faulty or undercapacity battery.	3. Replace battery.
4. Poor battery connections.	4. Clean and tighten or replace connections.
5. Faulty starter solenoid.	5. Replace or repair solenoid.
6. Faulty starting motor or drive.	6. Overhaul starting motor.

SYMPTOM B - LOW CYLINDER COMPRESSION

POSSIBLE CAUSES	REMEDY
1. Burned or warped valves.	1. Overhaul cylinder head.
2. Improper valve lash.	2. Adjust to proper clearance.
3. Worn or broken piston rings.	3. Overhaul engine.
4. Defective cylinder head gasket.	4. Replace gasket.

SYMPTOM C - LACK OF FUEL

POSSIBLE CAUSES	REMEDY
1. Fuel lines clogged.	1. Clean fuel lines.
2. Low fuel supply.	2. Check amount of fuel in tank, fill if supply is low.
3. Clogged vent in fuel tank cap.	3. Clean or replace cap.
4. Break in fuel supply line allowing air to be drawn into fuel line.	4. Replace or repair lines.
5. Clogged fuel filter.	5. Service filter as recommended in applicable portion of ENGINE FUEL SYSTEM (SEC. 6M).
6. Water or ice in fuel system.	6. Thaw if frozen, and drain water out of tank and filters.
7. Defective fuel pump.	7. Make pressure test at pump outlet.
8. Dirty carburetor.	8. Clean carburetor.
9. Carburetor choke inoperative, or not properly adjusted.	9. Check choke operation and adjust as necessary.

SYMPTOM D - IGNITION TROUBLES

POSSIBLE CAUSES	REMEDY
1. Distributor points burned or corroded.	1. Clean or replace points.
2. Distributor points out of adjustment.	2. Adjust point gap.
3. Faulty spark plugs.	3. Clean or replace and adjust spark plug gap.
4. Defective wiring.	4. Inspect wiring and correct as required.
5. Ignition out of time.	5. Set ignition timing.

HARD STARTING (CONT.)

SYMPTOM D - IGNITION TROUBLES (Cont'd.)

POSSIBLE CAUSES	REMEDY
6. Defective ignition coil or condenser.	6. Test coil and condenser; replace if necessary.
7. Cracked distributor cap.	7. Install new cap.

LACK OF POWER

SYMPTOM A - POOR COMPRESSION

POSSIBLE CAUSES	REMEDY
1. Incorrect valve lash.	1. Adjust to correct clearance.
2. Leaky valves.	2. Remove cylinder head and grind valves.
3. Valves or lifters sticking.	3. Free up or replace.
4. Weak or broken valve springs.	4. Replace defective springs.
5. Valve timing incorrect.	5. Correct the valve timing.
6. Blown cylinder head gasket.	6. Replace gasket.
7. Broken or stuck piston rings.	7. Free up or replace piston rings.
8. Worn pistons, ring, and/or cylinder bores.	8. Overhaul engine.

SYMPTOM B - IGNITION SYSTEM MALFUNCTION

POSSIBLE CAUSES	REMEDY
1. Ignition out of time.	1. Set ignition timing.
2. Defective spark plugs.	2. Clean or replace spark plugs.
3. Distributor points worn or out of adjustment.	3. Clean and adjust points or replace.

SYMPTOM C - LACK OF FUEL

POSSIBLE CAUSES	REMEDY
1. Dirt or water in carburetor.	1. Clean carburetor.
2. Gas lines partly clogged.	2. Clean gas lines.
3. Dirt in gas tank.	3. Clean gas tank.
4. Air leaks in gas line.	4. Tighten and check gas lines.
5. Fuel pump not functioning properly.	5. Replace or repair fuel pump.
6. Governor malfunction.	6. Repair or replace governor.

SYMPTOM D - EXCESSIVE FUEL (FLOODING)

POSSIBLE CAUSES	REMEDY
1. Choke not fully open.	1. Check choke and adjust control.
2. Air cleaner restricted.	2. Service air cleaner.
3. Carburetor float valve not seating.	3. Clean float valve and set float level.
4. Rich mixture at idle speed.	4. Adjust carburetor idle mixture.

LACK OF POWER (CONT.)

SYMPTOM D - FAULTY ACCELERATION

POSSIBLE CAUSES	REMEDY
1. Defective carburetor (accelerator pump - clogged jets).	1. Repair or replace carburetor.
2. Defective governor.	2. Repair or replace governor.
3. Air leak at intake manifold.	3. Replace gaskets and/or manifold.
4. Faulty ignition wiring.	4. Inspect for excessive resistance and defective insulation.
5. Misfiring spark plugs.	5. Clean and/or replace spark plugs.
6. Lack of cylinder compression, due to worn piston rings, burned valves, or defective head gasket.	6. Replace defective parts or overhaul engine.
7. Exhaust back pressure too high.	7. Replace or repair defective exhaust system components.

OVERHEATING

POSSIBLE CAUSES	REMEDY
1. Loose or defective fan belt.	1. Adjust or replace belt.
2. Thermostat not opening.	2. Replace thermostat.
3. Coolant loss.	3. Check for leaks and repair as necessary.
4. Partially clogged radiator.	4. Clean radiator core internal passages, and air passages.
5. Defective water pump.	5. Repair or replace pump.
6. Incorrect ignition or valve timing.	6. Retime engine.
7. Dragging brakes.	7. Adjust or repair brakes.
8. Restricted exhaust system.	8. Clean or replace exhaust system components.
9. Improper valve clearances.	9. Adjust valve clearance.
10. Ignition distributor advance inoperative.	10. Repair distributor to correct malfunction.
11. Overloaded vehicle.	11. Reduce load per vehicle rating.

NOTE: When operating vehicle in hot climate or at high altitudes, it may be necessary to check pressure cap and/or use cap with higher opening pressure to prevent boiling.

ROUGH IDLE AND/OR STALLING

SYMPTOM A - ERRATIC RUNNING OR SURGING

POSSIBLE CAUSES	REMEDY
1. Idle mixture too rich.	1. Adjust idle mixture screws.
2. Improper ignition timing.	2. Set timing.
3. Vacuum leak (air entering intake manifold).	3. Replace gasket, or tighten manifold bolts. Check and/or replace vacuum brake hose (when used).

ROUGH IDLE AND/OR STALLING (CONT.)

SYMPTOM A - ERRATIC RUNNING OR SURGING (Cont'd.)

POSSIBLE CAUSES	REMEDY
4. Inoperative crankcase ventilation valves.	4. Clean or replace valves.
5. Cylinder head gaskets leaking, or cylinder head cracked.	5. Replace cylinder head or gasket.
6. Worn valve guides.	6. Overhaul cylinder head.

SYMPTOM B - STALLING

POSSIBLE CAUSES	REMEDY
1. Engine idle speed set too slow.	1. Adjust idle speed to specifications.
2. Engine running too cool.	2. Install proper thermostat.
3. Exhaust restricted.	3. Repair exhaust system to eliminate excessive back pressure.
4. Carburetor flooding.	4. Replace defective float valve, set carburetor float level. Check fuel pump for excessive pressure.
5. Defective fuel pump.	5. Replace pump.

DETONATION (SPARK KNOCK OR PING ON ACCELERATION)

POSSIBLE CAUSES	REMEDY
1. Ignition advance too far for fuel being used.	1. Retard ignition timing.
2. Wrong type (heat range) spark plug.	2. Install correct spark plug.
3. Excessive build-up of deposits in combustion chambers.	3. Clean combustion chambers.
4. Restricted coolant passages in cylinder head causing "hot spots" in combustion chamber.	4. Remove cylinder head and clean passages.
5. Overheated engine.	5. Make corrections to lower the engine operating temperature. (Refer to "Causes" and "Remedies" previously covered under "Overheating.")
6. Lugging engine.	6. Use lower transmission gear to prevent overloading engine.

HIGH LUBRICATING OIL CONSUMPTION

POSSIBLE CAUSES	REMEDY
1. Oil lines or connections leaking.	1. Tighten or replace defective parts.
2. Leaking gaskets.	2. Replace gaskets as necessary.
3. Crankcase oil level too high.	3. Drain crankcase and refill to correct level.
4. Crankshaft oil seals worn.	4. Replace oil seals.
5. Pistons and/or rings worn, or pistons damaged; cylinder bores scored or worn.	5. Overhaul engine.

LOW ENGINE OIL PRESSURE

(When checked with engine at normal operating temperature)

POSSIBLE CAUSES	REMEDY
1. Defective oil gauge or sending unit.	1. Check pressure with master gauge. Replace oil gauge or sending unit if defective.
2. Oil viscosity too low.	2. Fill crankcase with correct oil.
3. Oil diluted with gasoline.	3. Check for indications of choke malfunction or carburetor flooding allowing gasoline to enter crankcase. Make necessary correction.
4. Suction loss.	4. Check for loose intake pipe and screen in oil pan. Also check for partially clogged inlet screen.
5. Weak or broken relief valve spring in oil pump.	5. Inspect spring and replace if necessary.

ENGINE NOISE

SYMPTOM A - VALVE MECHANISM NOISE

POSSIBLE CAUSES	REMEDY
1. Sticking valves.	1. Clean and lubricate valve stems.
2. Incorrect valve lash.	2. Adjust valve lash.
3. Bent push rod(s).	3. Determine and correct cause of push rod bending. Install new push rod.
4. Worn rocker arms and/or shaft.	4. Replace worn parts and make sure oil is reaching valve rocker arms.
5. Broken valve spring.	5. Replace spring.
6. Damaged valve lifter and/or camshaft.	6. Replace lifter and/or camshaft.

SYMPTOM B - BEARING NOISE

POSSIBLE CAUSES	REMEDY
1. Insufficient oil supply.	1. Check oil level and add oil as required.
2. Low oil pump pressure.	2. Remove and inspect oil pump and inlet screen. Make necessary corrections.
3. Thin or diluted oil.	3. Change oil. Use oil with proper viscosity.
4. Excessive bearing clearance.	4. Remove oil pan and make bearing replacement or repairs.
5. Piston pins loose fit in connecting rod or piston.	5. Install new piston pins (oversize pins if req'd.).
6. Piston to cylinder bore clearance excessive (piston slap).	6. Overhaul engine.

NOTE: When diagnosing engine noise problems, be careful that noises caused by accessories such as air compressor and power take-off are not mistaken for engine noises. Removal of accessory drive belts will eliminate any noises caused by these units.

Inspect engine front and rear mountings as part of regular engine maintenance program. Be sure all bracket attaching bolts are kept tight. Refer to ENGINE MOUNTINGS (SEC. 6D) for engine mounting information.

USE ENGINE OIL AS SPECIFIED IN LUBRICATION (SEC. 0) AND SERVICE CRANKCASE VENTILATION UNITS AND OIL FILTERS REGULARLY.

SECTION 6C

53 AND 71 SERIES DIESEL ENGINES

This group is divided into two sections covering 53 Series and 71 Series Diesel engines respectively. The 6V-53 Series engines are used in HV, JV, and TV 70 trucks. "Diesel Engine Application Chart" on page 434 shows 71 Series engine usage in 90 Series trucks. Refer to Index for major divisions of each section.

6V-53 DIESEL ENGINES

Contents of this section are listed in Index below:

ENGINE MAINTENANCE

SERVICING AIR CLEANERS

Regular servicing of the engine air cleaners is one of the most important maintenance items. Neglect of this service not only affects fuel economy, but the performance and life of the engine.

IMPORTANT: IN DUST STORM AREAS, AIR CLEANERS MUST BE SERVICED IMMEDIATELY AFTER SUCH STORMS OCCUR.

WARNING

USE EXTREME CAUTION TO BE SURE ALL VOLATILE CLEANING FLUID (GASOLINE, KEROSENE, ETC.) IS REMOVED FROM AIR CLEANER AT THE TIME OF CLEANING. UNCONTROLLED FUEL ENTERING COMBUSTION CHAMBER IN THIS MANNER CAN CAUSE THE ENGINE TO "RUN AWAY" AND POSSIBLY DESTROY ITSELF AND CAUSE INJURY TO PERSONNEL.

Engine air cleaners are oil bath type. Follow the procedure given in ENGINE FUEL SYSTEM (SEC. 6M) of this manual, to maintain air cleaners in serviceable condition.

FUEL SYSTEM

Make periodic inspection of fuel filters, lines, and injection units for evidence of leaks and damage. Repair as necessary. Also, check operation of accelerator control linkage for free movement. Check operation of engine stop mechanism which must function perfectly.

Refer to applicable portion of ENGINE FUEL SYSTEM (SEC. 6M) in this manual, for detailed information on fuel filters, governor control mechanism and servicing fuel injectors.

Fuel system units which require periodic maintenance services are:

1. Engine air cleaners and fuel filters - care must be taken when filling fuel tank to prevent entry of dirt and water.
2. Fuel lines and connections - should be inspected regularly for evidence of leaks.

IMPORTANT: Fuel system must be primed when engine has run out of fuel.

If gasoline is inadvertently poured in the fuel tank and the engine is operated, the entire system must be drained, otherwise the life of fuel system components may be adversely affected.

THE FUEL FOR GMC TRUCK DIESEL ENGINE MUST BE OF GOOD QUALITY, GRADE 2 AND SHOULD BE OBTAINED FROM A RELIABLE SUPPLIER. USE CARE IN STORAGE AND IN HANDLING DIESEL FUEL TO PREVENT CONTAMINATION BY DIRT AND WATER. DO NOT SMOKE WHEN HANDLING FUEL.

NOTE: In case of complaints of hard starting in cold weather, refer to suggested remedies in "Troubleshooting" under "Hard Starting" later in this section.

CRANKCASE OIL LEVEL AND VISCOSITY CHECK

An oil level dipstick at left side of engine is provided for checking crankcase oil level. Dipstick is marked "L" and "F."

When checking engine oil level, make note of oil viscosity. If there is evidence of crankcase oil dilution as indicated by oil appearing too "thin" or by level above the "F." mark on dipstick, make necessary investigation to determine cause of dilution and make necessary corrections.

ENGINE OIL FILTER ELEMENT

Oil filter element changing periods are related to crankcase oil changing periods, the quality of oil used and severity of service. Refer to LUBRICATION (SEC. 0) for element replacement, oil change periods, oil specifications, and viscosity.

COOLING SYSTEM INSPECTION

Refer to ENGINE COOLING SYSTEM (SEC. 6K) for arrangement of cooling system units and for inspection and required maintenance procedures.

CYLINDER HEAD BOLTS

Normally the cylinder head bolts should not require retightening at tune-up intervals. When necessary to tighten cylinder head bolts, refer to "Cylinder Head Replacement" covered later in this section, for bolt tightening sequence.

BATTERY AND BATTERY CABLES

If battery is weak or shows other evidence of being defective, refer to appropriate coverage in ENGINE ELECTRICAL (SEC. 6Y) of this manual, for method of diagnosing battery deficiencies.

CHARGING CIRCUIT WIRING AND GENERATOR INSPECTION

Refer to ENGINE ELECTRICAL (SEC. 6Y) in this manual for procedure required to check performance of charging circuit units.

CHECKING DRIVE BELTS

1. Inspect drive belts for excessive wear and damage. If no defects are found, check belts for proper tension.

2. When installing new drive belts or adjusting old belts, use tension gauge to provide correct tension.

IMPORTANT: Adjusting drive belts too tightly will impose too great a load on bearings in the driven units. Slipping will occur if drive belts are not adjusted tight enough. Belt life will be shortened if belts are not properly tightened.

Refer to ENGINE COOLING SYSTEM (SEC. 6K) for fan belts, to AIR COMPRESSOR AND GOVERNOR (SEC. 6T) for air compressor belts, to ENGINE ELECTRICAL (SEC. 6Y) for generator belts, and STEERING SYSTEM (SEC. 9B) for power steering belts in this manual for adjustment procedure of drive belts.

MANIFOLD BOLTS

Exhaust manifolds are secured by locks and nuts. At tune-up interval, check all exhaust manifold nuts for proper torque.

ENGINE TUNE-UP OPERATIONS

PRELIMINARY OPERATIONS

Perform the preliminary procedures as described following:

Before tune-up adjustments are started, it is important that air cleaners and fuel filter are serviced. Crankcase breather tube and air box drains must be kept clean and unobstructed. Air box drains may be cleaned with compressed air.

IMPORTANT: Remove or loosen an air box hand hole cover, otherwise blower or end plate gaskets may be damaged by excessive air pressure.

Reference should be made to "Diagnosis and Troubleshooting" later in this section.

To completely tune up an engine, all major adjustments must be made by following the applicable tune-up sequence, after the engine has reached its normal operating temperature.

Since the adjustments are normally made while the engine is stopped, it may be necessary to run the engine between adjustments to prevent it from cooling off excessively.

1. Adjust exhaust valve clearance.
2. Time fuel injectors.
3. Adjust governor gap.
4. Position injector rack control levers.
5. Adjust maximum no-load speed.
6. Adjust idle speed.
7. Adjust buffer screw.

FINAL TUNE-UP OPERATIONS

ADJUST EXHAUST VALVE CLEARANCE

The clearance between the valve rocker arm bridge and the exhaust valve stem should be 0.024" (hot) when the engine is at operating temperature. The clearance is set with a feeler gauge inserted between one valve stem and the bridge, and the other end of the bridge resting on the other valve stem.

Maintaining normal operating temperature, 160°F.-185°F., is particularly important when adjusting valve clearance. If engine is allowed to cool off before setting any of the valves, the clearance when running at full load may become too small.

Insufficient valve clearance will result in loss of compression, misfiring of cylinders, and eventual burning of the valves and valve inserts. Excessive clearance will result in noisy operation, especially in the low speed range.

If the rocker arm bracket bolts, or cylinder head bolts are disturbed for any reason, the exhaust valve clearance should be adjusted to 0.026" (cold) before starting the engine (fig. 1).

NOTE: When checking exhaust valves with engine cold the 0.025" feeler gauge should pass freely between the end of one valve stem and rocker arm bridge and the 0.027" feeler gauge should not.

Recheck valve clearance with gauge (J-9708) after the engine has reached its normal operating temperature.

All valve clearances can be adjusted during one full revolution of the crankshaft. Cylinder numbers are identified in figure 2.

IMPORTANT: DO NOT check or adjust clearance with engine running.

With the engine at normal operating temperature, to adjust the valves proceed as follows:

1. Clean loose dirt from exterior of the engine and remove the valve rocker covers. Use new gaskets when installing the valve rocker covers.
2. Place fuel shut-down lever in the "NO-FUEL" position.

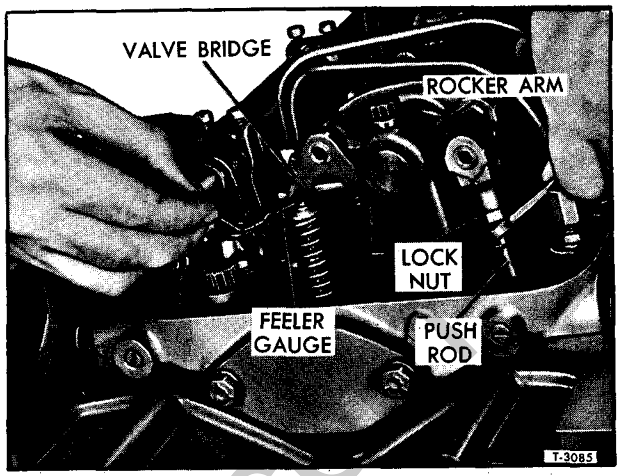


Figure 1—Exhaust Valve Clearance Adjustment

3. Rotate crankshaft (using the starter) until the injector follower is fully depressed on the particular cylinder to be adjusted.

NOTE: If using a wrench on the crankshaft bolt at the front of an engine, do not turn engine in a left-hand direction, as the crankshaft bolt will be loosened.

4. Loosen the push rod lock nut on the valve push rod (fig. 1), and placing a 0.025" feeler gauge tool (J-9708) between one valve stem and one end of the rocker arm bridge, adjust the push rod to obtain a smooth "pull" on the feeler gauge.
5. Remove feeler gauge and while holding the push rod, tighten the lock nut.

NOTE: Only one feeler gauge placed between one valve stem and the end of the rocker arm bridge is required to adjust clearance. The other end of the bridge will rest on the other valve stem during adjustment. When feeler gauge is removed both valves will have their proper clearance.

6. Recheck clearance with feeler gauge tool (J-9708). At this time, the 0.023" feeler gauge should pass freely between the end of one valve

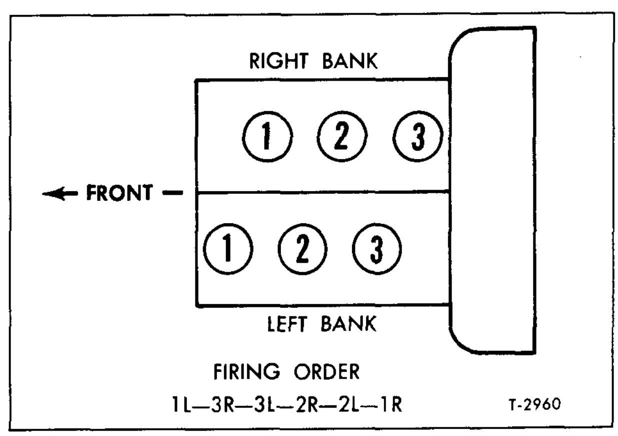


Figure 2—6V-53 Cylinder Numbering and Firing Order

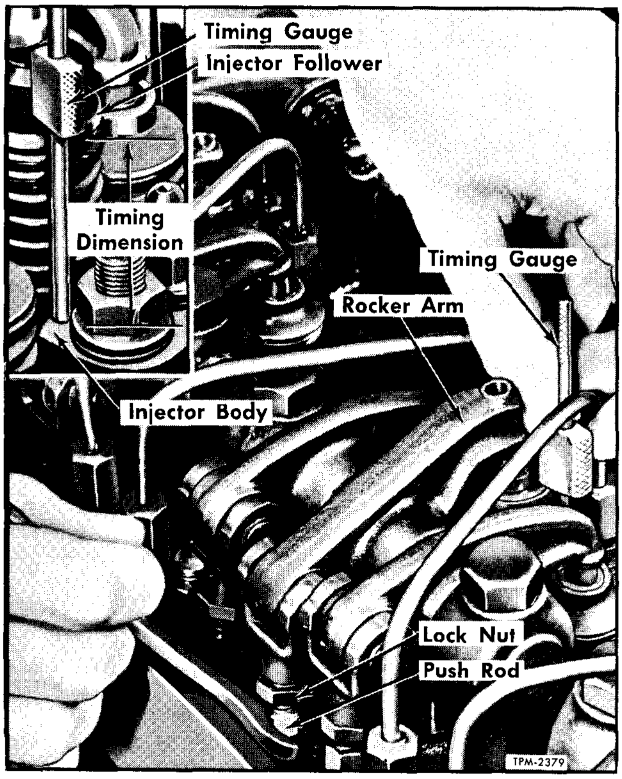


Figure 3—Timing Fuel Injectors (Typical)

stem and the rocker arm bridge and the 0.025" feeler gauge should not. Readjust as necessary.

7. Check and adjust remaining valves as outlined in Steps 2 through 6.

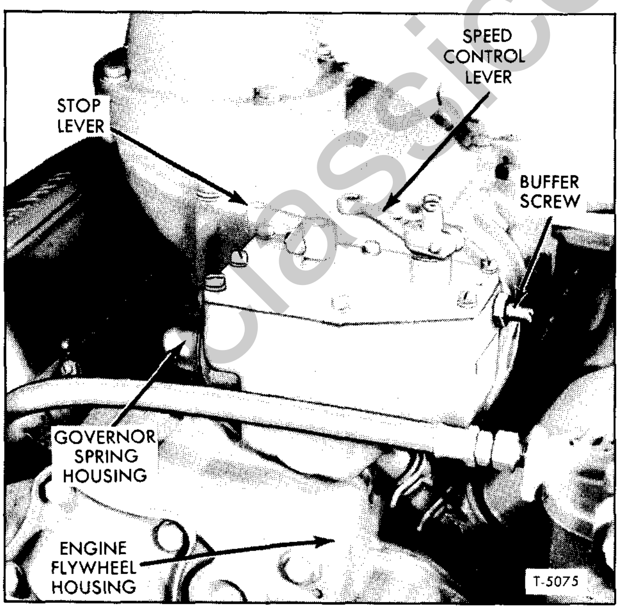


Figure 4—Limiting Speed Governor Mounting

TIME FUEL INJECTORS

To properly time the injectors, the injector follower must be adjusted to a definite height relative to the injector body.

NOTE: The engine must be at normal operating temperature.

All injectors can be timed during one full revolution of the crankshaft.

1. Place the engine stop lever in the "NO-FUEL" position.

2. Rotate the crankshaft in the direction of engine rotation until the exhaust valves are fully depressed on the particular cylinder to be timed.

IMPORTANT: If using a wrench on the crankshaft bolt at the front of an engine, do not turn engine in a left-hand direction, as crankshaft bolt will be loosened.

3. Place the small end of the injector timing gauge in hole provided in the top of the injector body, with the flat of the gauge toward the injector follower as shown in figure 3. Use the injector timing tool (J-1853) with a timing dimension of 1.460-inch. The gauge should just pass over injector follower.

4. When necessary to adjust, loosen push rod lock nut.

5. Turn the push rod until the extended part of the gauge will just pass over the top of the injector follower guide (fig. 3).

NOTE: Turning or spinning the timing gauge lightly with the finger tips will make it easier to determine the injector follower height and prevent cocking or tilting the gauge.

6. Hold the push rod and tighten the lock nut. Check adjustment and readjust if necessary.

7. Time the remaining injectors as outlined in Steps 1 through 6.

NOTE: It is important that all the injectors be set at the same height for best engine performance.

A method of checking injector follower height is as described following:

a. With the rocker arm covers removed, and engine at normal operating temperature and running at normal idle, place the small end of the injector timing gauge in the hole provided in the top of the injector body as shown in figure 3.

IMPORTANT: Since the engine is running, do not leave timing tool in injector body with engine running. DO NOT attempt to adjust or time injector with engine running as injector plunger could bottom and damage injector and operating mechanism.

b. When injector is properly set, by rotating or spinning timing tool with finger tips, the height of the follower can just be felt. If the follower is too low it cannot be felt. When the follower is too high it will bump the tool and should be reset so all injectors are same height.

ADJUST GOVERNOR GAP

The limiting speed mechanical governor assembly is mounted at the rear of the engine, between the flywheel housing and the blower (fig. 4). The governor is driven by the right blower rotor drive gear. The left blower rotor drive gear is driven by a shaft, that passes through the governor housing, from the engine gear train. Ordinarily this adjustment is necessary only when governor assembly is repaired or replaced.

With the engine at operating temperature, after adjusting the exhaust valves and timing the fuel injectors, set the governor gap as follows:

1. Stop the engine, remove the two bolts and withdraw the governor spring housing cover (fig. 4). Loosen buffer screw lock nut and back out slightly.

2. Loosen idle speed adjusting screw lock nut. Start engine and adjust idle screw (fig. 6) to obtain 15 rpm below desired idle speed. Tighten lock nut when properly adjusted. It is necessary to have proper low speed spring tension in order to set governor gap properly (see "Tune-Up Chart" later).

NOTE: It may be necessary to slightly adjust buffer screw to take out hunt or roll to stabilize idle speed for accurate setting.

IMPORTANT: The buffer screw should be adjusted with caution, since it contacts the connecting link, and turning the buffer screw in causes the injectors to go toward full fuel position.

3. Stop engine, remove the stop lever and speed control lever linkage (fig. 4); also the governor cover which is attached with seven screws.

4. Back out the buffer screw until it extends 9/16" to 5/8" from the surface of the governor housing. This is to prevent interference with differential lever while adjusting governor gap and setting injector control rack.

NOTE: Do not back the buffer screw out beyond the limits given, or the control link lever may disengage the differential lever.

IMPORTANT: DO NOT OVERSPEED ENGINE AS GOVERNOR IS NOW DISCONNECTED AND CANNOT CONTROL ENGINE SPEED.

5. Start and run the engine, between 800 and 1,000 rpm, by manual operation of the differential lever.

IMPORTANT: DO NOT OVERSPEED ENGINE.

6. Check the gap between the low speed spring cap and the high speed spring plunger with a 0.0015" feeler gauge. If the gap setting is incorrect, reset the gap adjusting screw (fig. 5).

7. Hold the gap adjusting screw and tighten the lock nut.

8. Recheck the gap and readjust if necessary.

9. Stop engine; install the governor cover. The governor cover should be placed on the housing with the pin of the speed control lever projecting into the slot of the differential lever. The stop lever should be set so it will pull the control rack in "NO-FUEL" position.

10. Install the screws and lock washers finger tight. Pull the cover away from the engine and tighten the screws. This step will properly locate the cover on the governor housing.

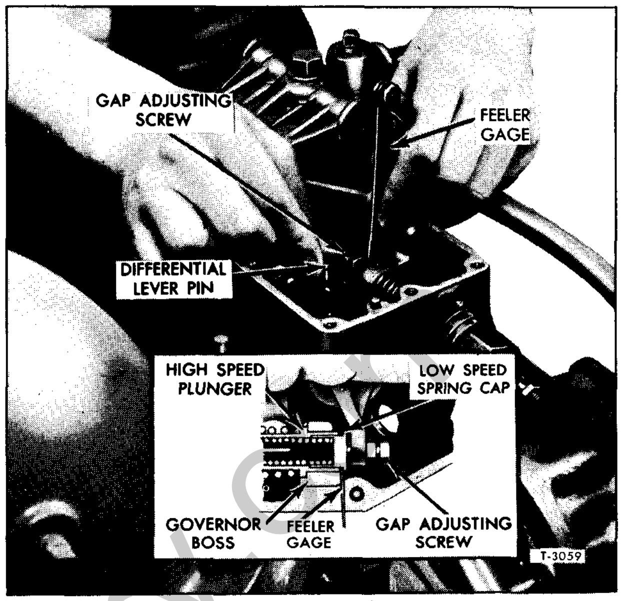


Figure 5—Low Speed Spring Gap Adjustment

POSITION INJECTOR RACK CONTROL LEVERS

The engine should be at normal operating temperature. Properly positioned injector rack control levers with the engine at full load will result in the following:

1. Speed control lever at the maximum speed position.

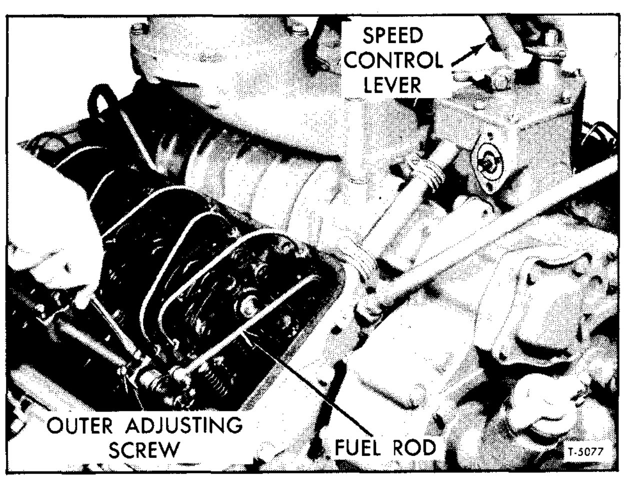


Figure 6—Positioning the Injector Rack Control Lever

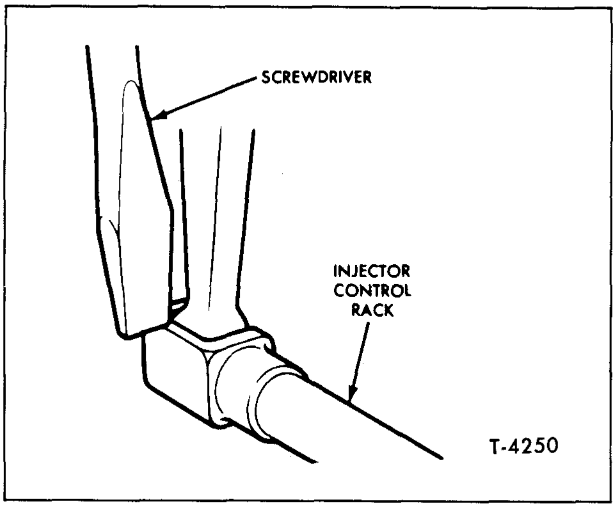


Figure 7—Checking Injector Rack Spring

2. Governor low speed gap closed.

3. High speed spring plunger on the seat in the governor control housing.

4. Injector fuel control racks in the full fuel position.

NOTE: The letters "R" or "L" indicate the injector location in the right or left cylinder bank, viewed from the rear of the engine (fig. 2). Cylinders are numbered starting at the front of the engine on each cylinder bank. Adjust the No. 3L injector rack control lever first to establish a guide for adjusting the remaining injector rack control levers.

a. Disconnect the linkage attached to the speed control lever, if not previously done.

b. Turn the idle speed adjusting screw so that about ½" of the screw projects from the lock nut.

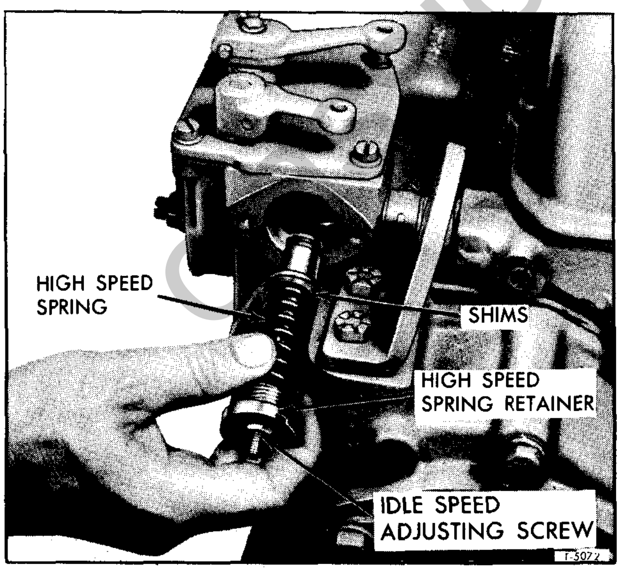


Figure 8—Adjusting Maximum No-Load Engine Speed (Typical)

NOTE: This adjustment lowers the tension of the low speed spring so it can be compressed, while closing the low speed gap, without bending the fuel rods.

c. Back out the buffer screw approximately 5/8" and remove valve rocker covers if it has not already been done.

d. Loosen all the inner and outer injector rack control lever adjusting screws on both injector control tubes. Be sure all the injector rack control levers are free on the injector control tubes, and that the injector rack control levers are not binding in the injector.

e. Move the speed control lever to the maximum speed position; hold it in that position with light finger pressure. Turn the inner adjusting screw on rear No. 3L (fig. 2) injector rack control down as shown in figure 6, until a slight movement of the control tube lever is observed or a step-up in effort to turn the screwdriver is noted. This will place rear No. 3L (fig. 2) injector in the full-fuel position. Turn down the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: The above step should result in placing the governor linkage and control tube assembly in the same positions that they will attain while the engine is running at full-load.

f. To be sure of the proper rack adjustment, the following check should be performed:

(1) Hold the speed control lever in the maximum speed position, and press down on the injector rack with a screwdriver or finger-tip causing the rack to rotate (fig. 7).

(2) The setting is sufficiently tight if the rack returns to its original position. If the rack does not return to its original position, it is too loose. To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw.

(3) The setting is too tight if, when moving the speed control lever from the idle to the maximum speed position, the injector rack becomes tight before the speed control lever reaches the end of its travel (stop under the governor cover). This will result in a slight step-up in effort required to move the speed control lever to its maximum speed position and a deflection in the fuel rod (fuel rod deflection can be seen at the bend). If the rack is too tight, back off the inner adjusting screw slightly and tighten the outer adjusting screw.

NOTE: After the number one injector rack control lever is correctly set, it must not be changed throughout the adjustment of the remaining injector rack control levers, since it is set to the governor gap.

g. Position No. 3R (fig. 2) injector rack control lever as previously outlined in Step 4e for the No. 3L injector rack control lever.

h. Repeat the check on the 3L and 3R (fig. 2) injector rack control lever as outlined in Step 4f. Check for and eliminate any deflection which may occur at the bend in the fuel rod where it enters the cylinder head.

NOTE: Both injector control racks should be the same.

i. Hold the speed control lever to the maximum speed or manually hold the No. 3L (fig. 2) injector rack in the full-fuel position with the lever on the end of the injector control tube, and turn the inner adjusting screw of the No. 2L (fig. 2) injector rack control lever down until the injector rack of the No. 2L (fig. 2) injector has moved into the full-fuel position. Turn the outer adjusting screw down until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

j. Recheck the No. 3L injector rack to be sure it has remained snug on the ball end of the rack control lever while positioning No. 2L injector rack. If the rack of the No. 3L injector has become loose, back off the inner adjusting screw slightly on the No. 2L injector rack control lever and tighten the outer adjusting screw.

NOTE: When the settings are correct, the racks of both injectors must be snug on the ball end of their respective rack control levers.

k. Position the No. 1L (fig. 2) injector rack control lever as outlined in Steps i and j.

l. Position No. 2R and 1R injector racks as outlined above for the left cylinder bank.

m. Turn idle speed adjusting screw in until it projects 3/16" from the lock nut to permit starting of the engine.

n. Use new gaskets and replace the valve rocker covers.

ADJUST MAXIMUM NO-LOAD ENGINE SPEED

All governors are properly adjusted before leaving the factory. However, if the governor has been reconditioned or replaced, and to ensure the engine speed will not exceed the recommended no-load speed as given on the unit name plate, set the maximum no-load speed as outlined following:

1. Start the engine and, after it reaches normal operating temperature place the speed control lever in the maximum speed position and note the engine speed.

2. Stop the engine and, if necessary, adjust the no-load speed as follows:

a. Remove the high speed spring retainer with tool (J-5895) and withdraw the high speed spring and plunger assembly (figs. 8 and 9).

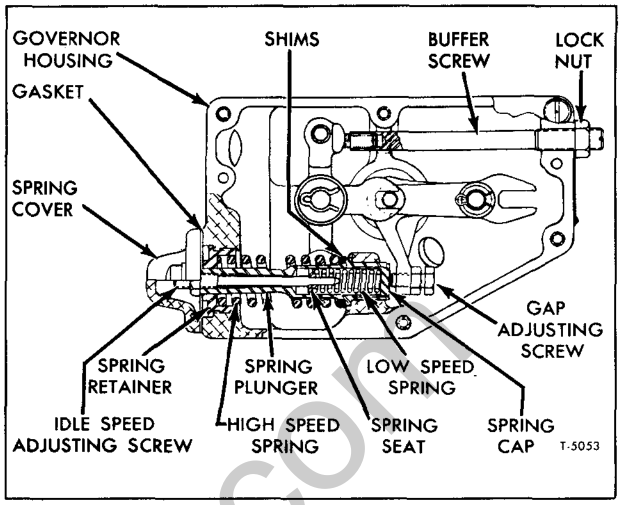


Figure 9—Governor Springs and Levers (6V-53 Engine)

CAUTION: To prevent the low speed spring and cap from dropping into the governor, be careful not to jar the assembly while it is being removed.

b. Remove the high speed spring from the high speed spring plunger and add or remove shims as required to establish the desired engine no-load speed.

NOTE: For each 0.010" in shims added, the engine speed will be increased approximately 10 rpm.

c. Replace the high speed spring on the plunger and install the spring assembly in the governor housing. Tighten the spring retainer securely. The maximum no-load speed varies with the full load operating speed.

EXAMPLE: If the full-load speed is to be 2600 rpm, then the no-load speed setting should be 2750 rpm to ensure the governor will move the injector racks into the full-fuel position at the desired full-load speed.

d. Start the engine and recheck the no-load speed. Repeat the procedure as necessary to establish the no-load speed required.

ADJUST IDLE SPEED

The engine must be at operating temperature when making final idle speed adjustment. With the maximum no-load speed properly adjusted, adjust the idle speed as follows:

1. Start engine and operate at idle speed while observing rpm at tachometer.

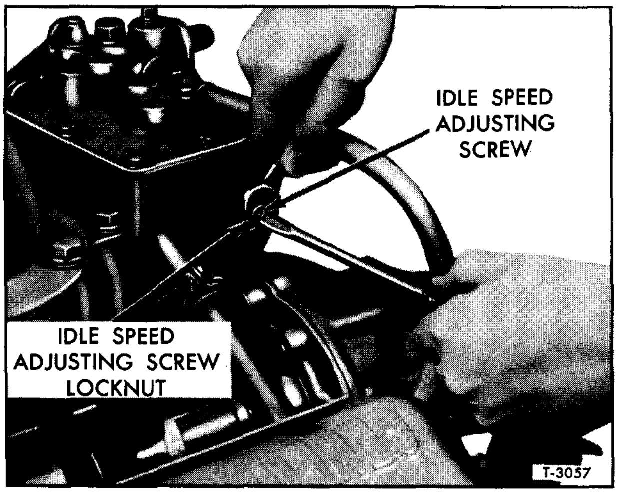


Figure 10—Adjusting Engine Idle

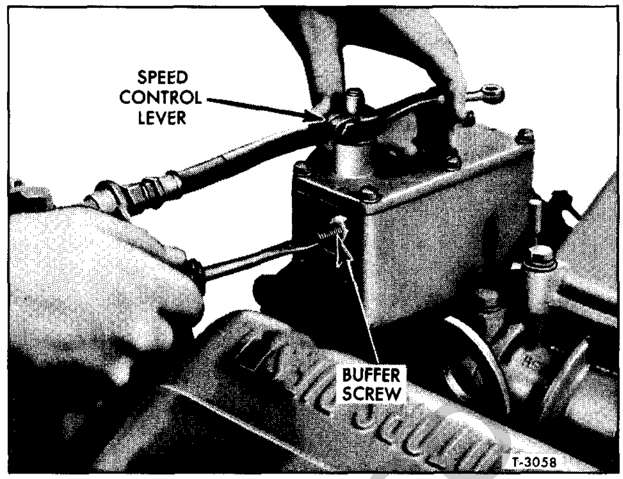


Figure 11—Adjusting Buffer Screw

IMPORTANT: It may be necessary to turn buffer screw in slightly to reduce surge or roll in engine. Do not increase engine rpm with buffer screw.

2. If necessary to adjust idle speed, loosen lock nut and turn idle adjusting screw IN to increase or OUT to decrease (fig. 10). Lock adjusting screw with lock nut when idle speed is approximately 15 rpm below desired setting. The recommended idle speed is 500 rpm.

ADJUST BUFFER SCREW

IMPORTANT: Turning buffer screw in too far will cause the engine to run at excessive speed making it difficult to shift axle and or transmission.

With the idle speed adjusted, and engine at operating temperature adjust buffer spring screw as follows:

1. Turn the buffer screw in (fig. 11) so it contacts the differential lever as lightly as possible and still eliminates the engine roll or surge.

NOTE: Do not increase engine idle speed more than 15 rpm with the buffer screw.

2. Hold buffer screw and tighten the lock nut.

3. Buffer screw can be checked for proper adjustment by accelerating engine and de-accelerating. When engine comes back to idle on de-acceleration it should roll one to two times and then level off to steady idle speed. If engine rolls or surges more than two times the buffer screw needs to be adjusted slightly in. If the engine does not roll or surge one to two times the screw is in too far. Adjust if necessary.

4. Recheck the maximum no-load speed. If it has increased more than 25 rpm, back off the buffer screw until the increase is less than 25 rpm.

5. Install governor spring housing cover (fig. 4) with two attaching screws.

6. Install throttle and stop linkage to governor cover levers.

7. Check throttle and stop linkage for proper adjustment as shown in ENGINE FUEL SYSTEM (SEC. 6M) of this manual.

6V-53 DIESEL ENGINE TUNE-UP CHART

Engine Type	6V-53 (2 Stroke Cycle)	Fuel Injector Type	N45
Number of Cylinders	6	Injector Valve Opening Pressure	2000-3200 Psi.
Cylinder Numbering	(See Figure 2)	Compression Ratio	21:1
Firing Order	1L-3R-3L-2R-2L-1R	Cylinder Compression	540 Psi**
Valve Lash	0.024" (Hot) or 0.026" (Cold)	Injector Timing Dimension	1.460"***
Cylinder Head Bolt Torque	190-200 Ft.-Lbs.*	Fuel Supply Pump	
Engine Idle Speed	500 Rpm	Capacity	
Engine Governed Speed		(At 1500 Engine Rpm)	90 Gal. Per Hr.
Full Load	2600 Rpm	Relief Valve Opens	
No Load	2750 Rpm	(Max. Lbs. Pressure)	75

* Threads and bolt heads coated with International Compound #2 (Part No. 5198563).
** With engine running at 600 rpm. Variation between cylinders not to exceed 25 psi.
*** Use injector timing gauge No. J-1853.

ENGINE REPLACEMENT (6V-53 DIESEL ENGINE)

GENERAL

This sub-section contains brief instructions for replacing engine, and for making replacement of engine components which can be made without removing engine from chassis.

CONVENTIONAL CAB MODELS

REMOVAL

1. Drain cooling system.
2. Disconnect battery.
3. If vehicle is equipped with air conditioning. it is necessary to disconnect refrigerant lines from condenser assembly which is mounted in front of radiator.

IMPORTANT: Only personnel familiar with air conditioning service procedures should attempt removal and/or installation of air conditioning units.

3. Disconnect accelerator control at pedal shaft lever at rear of engine. This is necessary to permit removal of engine access cover in cab.
4. Inside cab, remove floor mat, then remove floor pan above transmission. Remove transmission gearshift lever.
5. Remove engine access cover from cab.
6. Disconnect light wiring harness. Remove hood assembly, then remove grille brace bolts and support bracket bolts. Remove grille assembly.
7. Disconnect battery cable and wiring from starter, remove engine ground strap, and disconnect wiring harness connections at the generator, temperature sending unit, etc.
8. Remove air cleaner and air inlet hoses. Disconnect tachometer drive from engine and the engine oil gauge pressure line. Disconnect engine stop control and accelerator control linkage.
9. When vehicle is equipped with power steering, disconnect the power steering lines or remove pump assembly from engine and allow pump and lines to remain on chassis.
10. Disconnect exhaust pipes from manifold. Disconnect fuel supply and return lines.
11. Disconnect oil cooler lines from fittings at radiator lower tank. Also disconnect heater hoses.
12. Disconnect radiator hoses, vent line, and by-pass line. Remove radiator and support assembly.
13. Remove front bumper.
14. Remove front end sheet metal, referring to SHEET METAL AND FIBERGLASS (SEC. 11) in this manual for necessary information.
15. Detach clutch control cylinder from flywheel housing.
16. Disconnect air lines from air compressor.

NOTE: If desired, the air compressor may be removed from engine prior to engine removal.

17. Attach overhead hoist to engine, then remove two front mounting bolts at crossmember. Lift engine slightly to transfer engine weight to hoist, then remove clutch housing-to-flywheel housing bolts. Move engine forward to disengage clutch disc from transmission mainshaft, then lift engine out of vehicle.

Figure 12 is view inside cab with engine cover and transmission cover removed.

INSTALLATION

1. Using overhead hoist, move engine into position in vehicle. Mate splines in clutch disc with transmission drive gear splines.
2. Install clutch housing to flywheel housing bolts. Position front mountings at front crossmember and install bolts.
3. Connect tachometer drive shaft, clutch release cylinder, engine controls and engine wiring.
4. Connect air compressor air lines, and cooling and lubrication lines if compressor was removed.
5. Install air cleaner and hoses.
6. Connect fuel supply and return lines. Also, connect wiring and cables at starting motor, including engine ground strap.

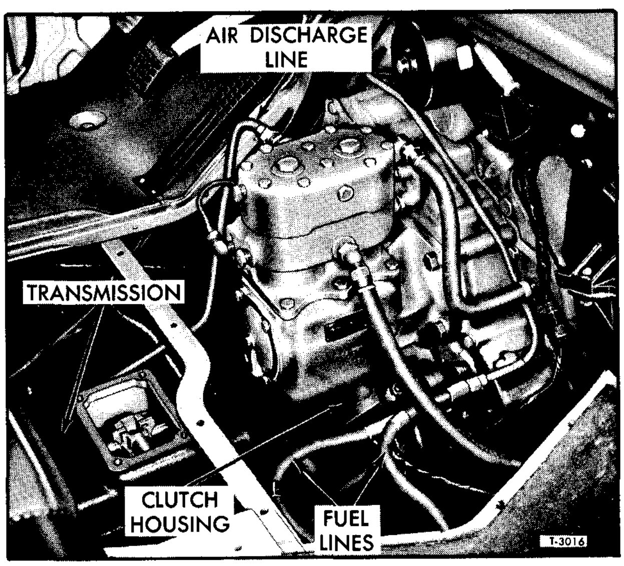


Figure 12—Access Cover and Floor Panel Removed from Cab (Typical)

7. Connect exhaust pipes to exhaust manifolds.
8. Install front bumper.
9. Install radiator and support assembly and connect radiator hose, vent line by-pass line.
10. Install accessories and adjust drive belts.
11. Install radiator grille, install hood assembly, then install access cover inside cab.
12. Install gearshift lever on transmission, install floor pan over transmission, and floor mat.
13. Connect air conditioning and lines, if equipped.
14. Fill cooling system and connect battery cables.
15. Start engine and inspect for cooling system and oil leaks.

TILT CAB MODELS

REMOVAL

1. Tilt the cab forward and drain the cooling system. Remove air cleaner and hoses.
2. Disconnect cables from the battery.
3. Disconnect equipment and wiring as necessary to allow removal of control island.
4. Remove attaching bolts, then remove control island and cab rear support.
5. Disconnect exhaust pipes at exhaust manifolds.
6. Disconnect radiator hoses and heater hoses.
7. Disconnect all starter cables, ground straps and other wiring connected to engine electrical equipment.
8. Disconnect power steering lines (when used).
9. Disconnect engine oil cooler lines.
10. Disconnect fuel supply and return lines.
11. Disconnect propeller shaft and speedometer drive at rear of transmission.
12. Disconnect clutch release linkage.
13. Disconnect air discharge line and lubrication lines from air compressor.
14. Attach overhead lifting equipment and raise until power plant is partially supported; then remove front and rear mounting bolts.
15. Lift power plant out of chassis, using care to prevent fouling of lines and wiring.
16. Remove transmission and clutch from engine, making reference to appropriate sections of manual for additional information required to properly separate the components.

INSTALLATION

Refer to applicable portion of TRANSMISSIONS AND CLUTCHES (SEC. 7) of this manual for information required to properly assemble clutch parts and transmission to engine.

1. Attach overhead hoist in manner to provide balance as engine is lifted into position.
2. With mounting brackets in place on engine, lift power plant into place. Locate engine front and rear mountings and install mounting bolts. Refer to ENGINE MOUNTINGS (SEC. 6D) for necessary information regarding engine mountings.
3. Connect air lines, lubricating oil lines, electrical wiring, and radiator and heater hoses. Connect oil cooler lines.
4. Connect propeller shaft and speedometer drive. Also, connect tachometer drive (when used).
5. Connect clutch control linkage.
6. Install control island and connect all wiring and transmission control rods. Install air cleaner and hoses.
7. Fill cooling system and check for leaks.
8. Make certain engine crankcase is filled to proper level with engine oil.
9. Connect battery cables, prime fuel system, and start engine. Adjust controls and inspect for oil leaks.

IN-VEHICLE ENGINE COMPONENT REPLACEMENT

ROCKER ARM COVER REPLACEMENT

1. Remove cover screws, then remove cover and gasket.
2. Reverse procedure in Step 1 to install rocker arm cover. Use new cover gasket.

VALVE SPRING REPLACEMENT (CYLINDER HEAD INSTALLED)

It is possible, if occasion requires, to remove or replace the exhaust valve springs without removing cylinder head. The springs, however, are normally removed when the head is off the engine.

An exhaust valve spring may be removed, without removing cylinder head from the engine as follows:

1. Remove valve rocker cover.
2. Crank the engine over to bring the valve and injector rocker arms in line horizontally.
3. Disconnect and remove the fuel lines from the injector and fuel connectors.
4. Remove the two bolts holding the rocker arm shaft brackets to the cylinder head and remove the brackets and shaft.

5. Remove cylinder block air box cover so that piston travel may be observed, then turn the crankshaft until the piston is at top of its stroke.

6. Thread the spring compressor tool into one of the cylinder head bolt holes (fig. 13). Then, compress the spring and remove two-piece valve lock.

7. Release the tool and remove the valve spring cap, valve spring, and spring seat.

8. Reassemble spring seat, spring, and spring cap, then use tool in same manner as described for removal to compress spring. Install two valve locking keys in groove in valve stem.

9. Swing rocker arms and brackets into place and install bracket bolts (fig. 14). Torque to "Specifications" at end of this section.

10. Check valve clearance and injector timing, referring to instructions previously given in "Final Tune-up Operations" under "Exhaust Valve Adjustment" and "Time Fuel Injectors."

11. Install rocker arm cover.

CYLINDER HEAD REPLACEMENT

The cylinder head and/or gasket at either right-hand or left-hand cylinder bank may be replaced in manner described below:

REMOVAL

1. Drain cooling system. Remove engine access cover from inside cab (fig. 12).

2. Disconnect battery to prevent damage from accidental short-circuiting of wiring.

3. Disconnect exhaust pipe from exhaust manifold. Remove air cleaner.

4. Remove exhaust manifold stud nuts and special clamp washers, then remove exhaust manifold and gasket.

5. At front of cylinder head remove thermostat housing and accessory brackets (when used).

6. Disconnect fuel lines from fittings at front of cylinder head. When removing left-hand head, disconnect fuel return line from fitting at rear of head.

7. Remove rocker arm cover from head (fig. 14).

8. Remove cover from governor housing. Remove nut (5, fig. 15) from fuel rod, then remove

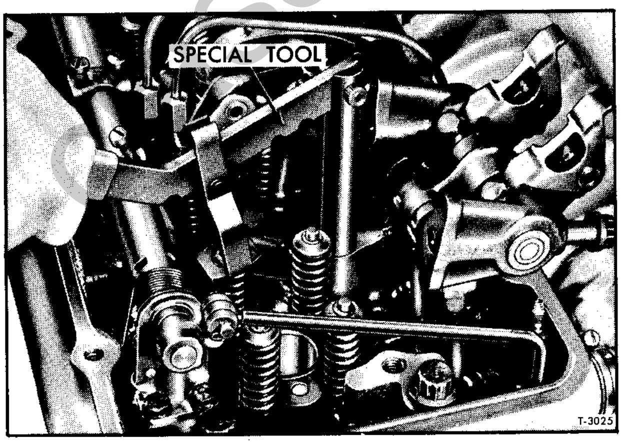


Figure 13—Use of Special Tool for Removing Valve Spring with Cylinder Head Installed

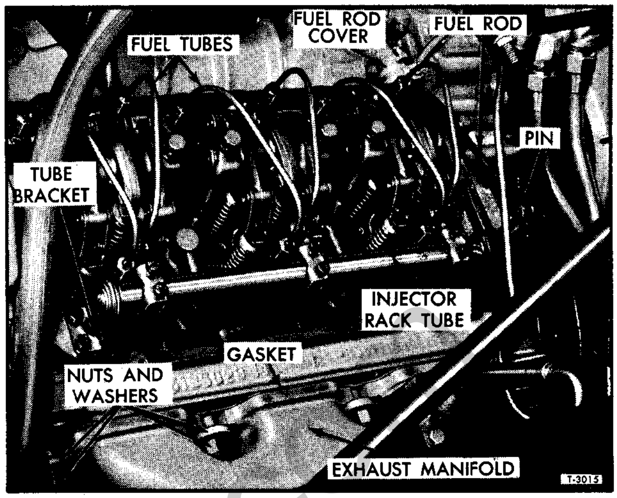
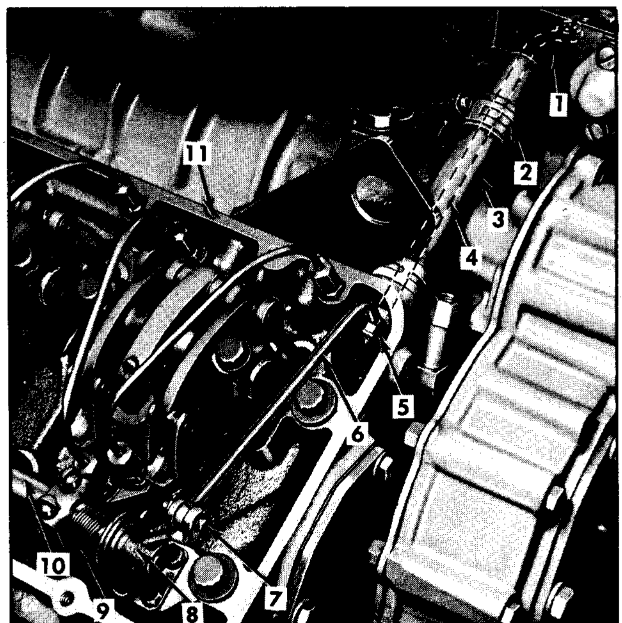


Figure 14—6V-53 Engine with Left Hand Rocker Arm Cover Removed



1 Governor Housing	7 Link Pin
2 Hose and Clamp	8 Injector Control Tube Lever
3 Control Rod Cover	9 Control Tube Spring
4 Fuel Control Rod	10 Control Tube
5 Rod Nut	11 Cylinder Head (L.H.)
6 Lower Link	

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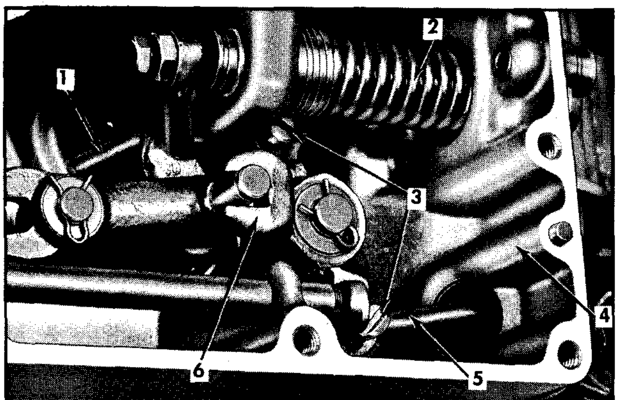
Figure 15—Fuel Rod and Link Installation



1 Fuel Rod to R.H. Cylinder Head
2 Governor Springs
3 Fuel Rod-to-Lever Screws
4 Governor Housing
5 Fuel Rod to L.H. Cylinder Head
6 Fuel Rod Operating Lever

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Figure 16—Governor Housing Cover Removed Showing Fuel Rod Connecting Screws

pin (7, fig. 15) attaching link to tube lever and remove link (6, fig. 15).

9. Inside governor housing (fig. 16), remove screw which attaches fuel rod to lever in housing, then remove rod.

10. Loosen hose clamps, then move hoses as necessary to permit removal of rod cover (tube)

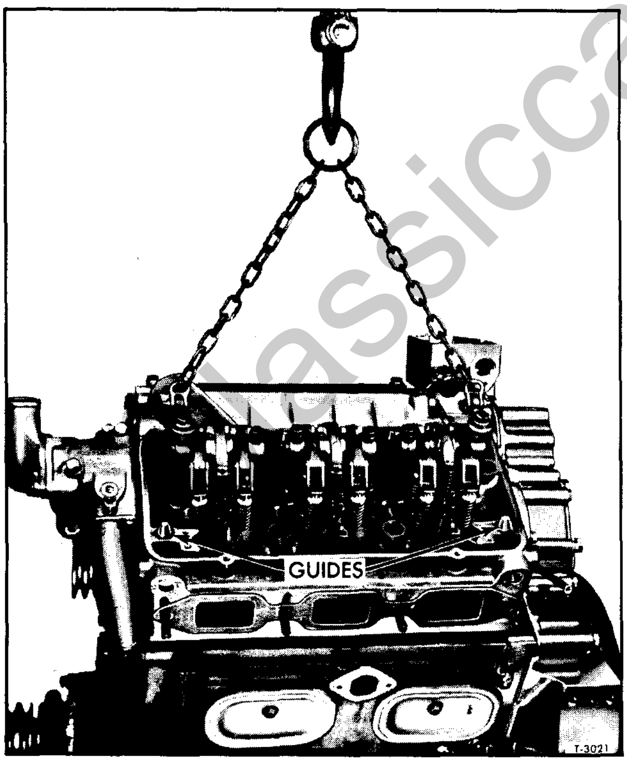


Figure 17—Installing Cylinder Head on Engine

(3, fig. 15).

11. Remove injector rack control tube and bracket assembly.

12. Remove cylinder head bolts in gradual stages to relieve spring pressure. When bolts have been removed, lift cylinder head assembly off cylinder block. Remove seals and gaskets from cylinder liners and from recesses in block.

CAUTION: When resting the cylinder head assembly on a bench, protect the cam follower rollers and injector spray tips by resting the valve side of the head on wooden blocks approximately two inches thick.

13. Remove cylinder head compression gaskets, oil seals, and water seals from block. Clean the cylinder head surface which mates with cylinder block.

CYLINDER HEAD INSTALLATION (Fig. 17)

1. Inspect top of pistons to see that they are clean and free from carbon deposits. Also check and, if necessary, remove any deposits found in groove and counterbores in top of cylinder block.

2. Install new cylinder head compression gaskets and seals as follows:

a. Install a new compression gasket on each cylinder liner.

b. Place new seal rings in the counterbores of water and oil holes in cylinder block.

c. Install a new oil seal in milled groove near the outer edge of area covered by cylinder head.

NOTE: Used water seals, oil seals, and compression gaskets should never be re-used.

3. Install guide studs (fig. 17) in head bolt holes in cylinder block to ensure positive location of head without disturbing seals and gasket.

CAUTION: Compression gaskets and/ or seals which are jarred out of their proper location will allow leaks and "Blow-by" which will result in poor performance and damage to engine.

4. Wipe bottom of cylinder head clean, then lower cylinder head (fig. 16) onto guide studs and down into contact with block. Lubricate threads and pressure area of bolt heads with International Compound #2 or equivalent, then start all cylinder head bolts. Beginning at camshaft side of cylinder head tighten head bolts lightly to overcome tension of cam follower springs.

5. Tighten cylinder head bolts about one-half turn in sequence shown in figure 18. Use torque wrench for final tightening of cylinder head bolts.

Correct torque is 170 to 180 foot-pounds. Do not tighten bolts beyond specified torque.

6. Cover oil drain holes in head to prevent foreign objects from falling into holes. Install injectors (if removed) referring to applicable portion of ENGINE FUEL SYSTEM (SEC. 6M) in this manual, for instructions. Check push rods to see that each one is threaded completely through clevis, then tip rocker arms into position with the valve bridges squarely positioned at valve stems. Install rocker arm shaft bracket bolts and tighten to 50 to 55 foot-pounds torque.

7. Set injector control tube and lever assembly in place and install attaching bolts finger tight. Check injector control tube levers for engagement with slots in injector control racks. Also, be sure ends of rack control tube return spring are properly hooked; i.e., one end hooked around the control tube lever and other end hooked around adjacent control tube bracket. Tighten bracket to head bolts with universal socket and torque to 10 to 12 foot-pounds.

8. Try operating the injector control tube to determine if return spring rotates tube back to "NO-FUEL" position after tube is manually moved to "FULL-FUEL" position. If there is binding present, strike the control tube brackets lightly with soft hammer to correct any misalignment of tube bearings.

9. Referring to figures 15 and 16, install fuel rod through opening in top of governor housing; pass rod through hoses, clamps, and tubular cover (used at left-hand head). Attach fuel rod to governor lever with screw (3, fig. 16) inside governor housing. Install governor housing cover with new gasket. Assemble hose and clamps to secure fuel rod cover.

10. Install fuel link between fuel rod and lever on control tube. Link is pinned to lever and secured to rod by nut (fig. 15).

11. Connect fuel line at fitting at rear of left-hand cylinder head.

12. Use new gasket and mount thermostat housing on front of cylinder head.

13. Use new gasket and install exhaust manifold. Tighten manifold stud nuts to 25 to 40 foot-pounds.

14. Connect exhaust pipe. Fill cooling system and check for leaks.

15. Refer to "Engine Tune-up" covered previously in this section, adjust exhaust valve clearance and set injector timing.

16. Start engine and operate until normal operating temperature is reached, then recheck cylinder head bolt torque and make final check of exhaust valve clearance, injector timing, and other tune-up operations.

17. Install rocker arm cover on cylinder head, using new gasket. Install air cleaner.

ENGINE OIL PAN REPLACEMENT

The oil pan, attached to the bottom of the engine, is made of pressed steel. A one-piece oil pan gasket is used.

1. Remove the drain plug and drain the engine lubricating oil.

2. Detach the oil pan; take precautions to avoid damaging the oil pump inlet pipe and screen. If desired the inlet pipe assembly and gasket can be readily replaced.

3. Remove the oil pan gasket completely, then clean flange surfaces.

4. Clean the oil pan with a suitable solvent; dry the oil pan.

5. Inspect the oil pan for large dents or breaks in the metal which may necessitate its repair or replacement. Check for misaligned flanges or raised surfaces surrounding bolt holes by placing the pan on a surface plate or other large flat surface.

6. When replacing the pan, use a new gasket and tighten the bolts evenly to avoid damaging the gasket or springing the pan.

7. Install the oil drain plug. Replenish crankcase lubricating oil.

CRANKSHAFT PULLEY AND FRONT OIL SEAL REPLACEMENT

REMOVAL

1. Remove the radiator core with attached radiator shell assembly as directed in SHEET METAL AND FIBERGLASS (SEC. 11) in this manual.

2. Remove drive belts from crankshaft pulley, then remove pulley attaching bolt and flat washer.

3. Remove pulley from crankshaft as follows:

a. Reinstall the pulley attaching bolt only. Make sure bolt is tightened firmly.

b. Using puller tool (J-4794-01) or equivalent, pull the pulley from crankshaft.

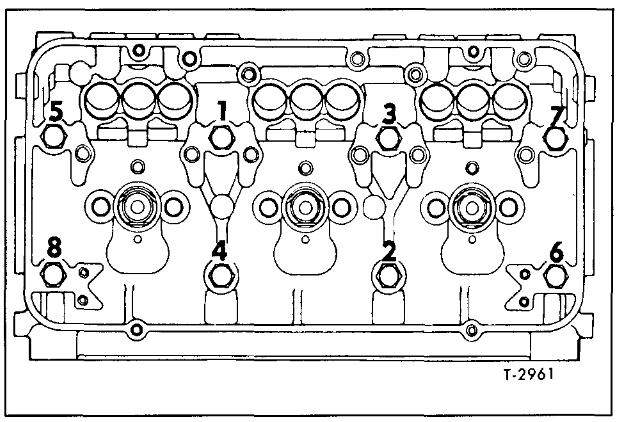


Figure 18—Cylinder Head Bolt Tightening Sequence

NOTE: Two tapped puller holes are provided in the pulley for this purpose.

4. Using a small bit, drill two diametrically opposite holes in the oil seal casing.

5. Thread two sheet metal screws with a flat washer on each one into holes in seal, then using two small pry bars under the washers, force the seal assembly outward from front cover.

IMPORTANT: Be careful not to damage the seal surface on crankshaft.

INSTALLATION

1. Carefully clean any old sealant from bore in front cover.

2. Apply thin coat of sealant to outer diameter of new seal assembly. Also, apply a coat of clean grease to lip of oil seal.

3. With the lip of seal pointed toward engine, start seal assembly into bore of front cover. Using a hollow tube as a driving tool against outer diameter of seal, tap the seal assembly evenly until

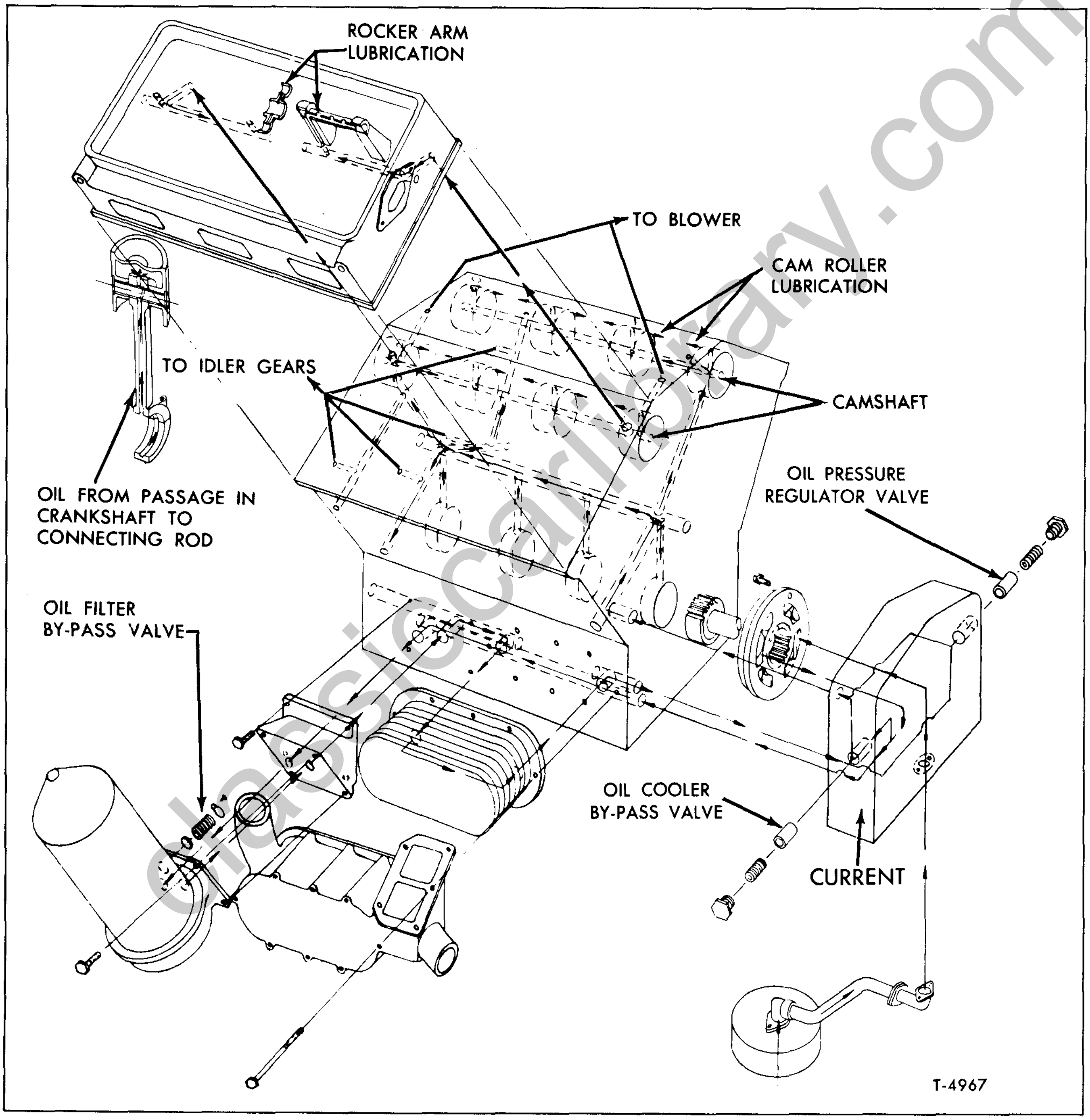


Figure 19—Schematic Diagram of 6V-53 Engine Lubrication System

flush with the outer face of front cover.

4. Start pulley straight and true on crankshaft.

NOTE: A special installer tool (J-7773) can be used to install pulley or an improvised tool consisting of a ¾"-16 x 4" bolt and a flat piece of bar stock with a center hole can be used. Bar stock length should be slightly longer than diameter of pulley.

5. After pressing pulley on crankshaft, install attaching bolt with flat washer to 200 to 220 foot-pounds torque.

6. Install belts, radiator and sheet metal.

ENGINE LUBRICATION (6V-53 DIESEL ENGINE)

The engine lubrication system for the 6V-53N engine, schematically illustrated in figure 19, includes an oil intake screen and tube assembly, an oil pump, an oil pressure regulator valve, a full-flow oil filter with a by-pass valve, an oil cooler, and an oil cooler by-pass valve.

The rotor-type oil pump is bolted to back of engine lower front cover and is driven directly by the crankshaft. Inlet to the oil pump is through a fixed-type inlet screen in the oil pan sump.

Lubricating oil from the pump passes from the lower front engine cover through short gallery passages in the cylinder block. From the block, oil flows to the full-flow filter, then through the oil cooler and back into the front engine cover and cylinder block oil galleries for distribution to various engine bearings. The oil drains from the cylinder head and other engine parts back to the oil pan.

A replaceable element-type full-flow filter installed between the oil pump and oil cooler, filters the oil prior to entering the engine. If filter becomes restricted, the oil will flow through a by-pass valve, which opens at 18 to 21 psi, directly to the cooler.

The oil cooler by-pass valve is located on the right side of the engine front cover and the oil pressure regulator valve is located on the left side as viewed from the rear of the engine.

If oil cooler becomes restricted, the oil flow will be to a by-pass valve in lower engine front cover, then to the cylinder block oil galleries. The by-pass valve opens at approximately 52 psi.

Stabilized lubricating oil pressure is maintained within the engine at all speeds by means of a regulator valve located in the lower front engine cover. The regulator valve, located in the pump outlet passage, opens at approximately 52 psi and returns excess oil directly to the crankcase.

All crankshaft and connecting rod bearings are pressure lubricated. Oil passages branching off from the main oil gallery direct the oil to camshaft end bearings, idler gear and accessory drive gear bearings, blower, and cylinder heads.

Oil for lubricating connecting rod bearings, piston pins, and for cooling the piston heads is provided through the drilled crankshaft from the adjacent forward main bearings. The gear train is lubricated by the overflow of oil from the camshaft pocket through a passage into the flywheel housing.

TORQUE WRENCH SPECIFICATIONS

Torque figures shown are at various points indicated with threads clean and dry unless otherwise indicated.

Item	Ft.-Lbs.
Cylinder Head Bolts and Nuts	190-200*
Exhaust Manifold Stud Nuts	30-35
Rocker Arm Shaft Bracket Bolts	50-55
Pulley and Damper to Crankshaft Bolt	290-310
Oil Filter Center Bolt	40-50
Oil Pan Drain Plug	35-40
Rack Control Tube Bracket Bolts	10-12
Front Cover Bolts	
3/8-24	25-30
1/2-13	80-90
Oil Pan Bolts	10-12

* Bolt and stud threads, nuts, and bolt head contact areas coated with International Compound #2 or equivalent. International Compound #2 is available in quart containers - Part Number 5198563.

71 SERIES DIESEL ENGINES

Contents of this section are listed in Index below:

GENERAL INFORMATION

The 71 Series Diesel engines used in vehicles covered by this section have similar basic design characteristics. Engines are all two-cycle, direct injection type. Four exhaust valves are used at each cylinder. Valves are operated in pairs. A rocker arm and valve bridge actuates each pair of exhaust valves. The injector for each cylinder is operated by separate rocker arm. The "Diesel Engine Application Chart" below shows standard and optional engines for each truck model.

ENGINE MAINTENANCE

Recommendations given under corresponding heading on page 419 in previous section on "6V-53 DIESEL ENGINES," is also applicable to engine maintenance on vehicles covered by this section.

DIESEL ENGINE APPLICATION CHART

TRUCK MODEL	STANDARD ENGINE	OPTIONAL ENGINE
HI 90	6-71 (N60)	6-71 (N65)
JI 90	6-71 (N60)	6-71 (N65)
MI 90	6-71 (N60)	6-71 (N65)
MH 90	8V-71 (N55)	8V-71 (N60) (N65)
FH 90	8V-71 (N55)	8V-71 (N60) (N65)
FI 90	6-71 (N60)	6-71 (N65)
DH 90	8V-71 (N55)	8V-71 (N60) (N65)
DI 90	6-71 (N60)	6-71 (N65)

ENGINE TUNE-UP OPERATIONS

PRELIMINARY OPERATIONS

Except as noted following, the procedures apply to the In-Line 6-71 and V8-71 Engines.

NOTE: For tune-up on vehicles equipped with engine brake system refer to "Engine Brake" later in 71 Series Diesel Engines section.

There is no scheduled interval for performing an engine tune-up. As long as the engine performance is satisfactory, no tune-up should be needed.

IMPORTANT: Before tune-up procedure is started it is important that air cleaners and fuel filters are serviced as described in applicable maintenance manuals. Crankcase breather tube and air box drains must be clean and unobstructed. Air box drains may be cleaned with compressed air.

Remove or at least loosen an air box hand hole cover, otherwise blower or end plate gaskets may be damaged by excessive air pressure.

Reference should be made to "Testing and Diagnosis" also to "Troubleshooting" later in this section for engine diagnosis, trouble symptoms, causes, and remedial measures.

To tune-up an engine completely, all of the adjustments, except the valve bridge adjustment on four-valve cylinder heads, are made by following the applicable tune-up sequence given following, after the engine has reached normal operating temperature. Since the adjustments are normally made while the engine is stopped, it may be necessary to run the engine between adjustments to maintain normal operating temperature.

NOTE: The exhaust valve bridges on the four-valve cylinder head are adjusted at the time the cylinder head is installed on the engine and, until wear occurs, no further adjustment is required. When wear is evident, perform a complete valve bridge adjustment as outlined following.

Results obtained from an engine tune-up are usually unsatisfactory, unless a step-by-step, systematic, and orderly approach is used. Proceed in the following sequence:

1. Bridge balancing adjustment.
2. Adjust exhaust valve clearance.
3. Time fuel injectors.
4. Adjust governor gap.
5. Position injector rack control levers.
6. Adjust maximum no-load speed.
7. Adjust idle speed.
8. Adjust buffer screw.

NOTE: Whenever a push rod has been disconnected from the clevis, the push rod must be screwed back into place until end of push rod appears through the clevis. If this is not done, the piston may hit the head of the valve when the engine is being turned, due to the small clearance, between the valves and piston head at the piston's upper position, or an injector plunger may "bottom" before being properly adjusted.

Clearance between exhaust valve stem and bridge with engine at operating temperature is important and should be maintained. Too little clearance causes a loss of compression, misfiring of cylinders and eventual burning of valves and valve seats. Too much clearance results in noisy operation of the engine, especially in the low speed range.

FINAL TUNE-UP OPERATIONS

BRIDGE BALANCING ADJUSTMENT
(4 VALVE HEAD) (71 SERIES ONLY)

The exhaust valve bridge assembly is adjusted and the adjustment screw locked securely at the time the cylinder head is installed on the engine. Until wear occurs with the operation of the engine, no further adjustment is required on the exhaust valve bridge. When wear is evident, make complete bridge balancing adjustment as outlined in the following steps:

1. Remove valve rocker cover, injector fuel jumper lines, then remove rocker shaft bracket bolts, brackets, and shaft. Lift rocker arms and swing back to provide accessibility to valve bridge.
2. Remove bridge from guide.
3. Place bridge in a vise and loosen adjusting screw lock nut.

IMPORTANT: Loosening or tightening the lock nut with the bridge in place may result in bending the bridge, bridge guide, or the rear valve stem.

4. Install bridge on bridge guide.
5. Press straight down on the pallet surface of bridge (fig. 1). Turn adjusting screw until it just touches the valve stem, then turn screw an additional 1/8 to 1/4 turn and tighten lock nut finger tight.
6. Remove bridge and place in a vise. With screwdriver, hold screw from turning and tighten lock nut on the adjusting screw. Complete the operation by tightening the lock nut to 25 foot-pounds torque, being sure that screw does not turn.

IMPORTANT: DO NOT tighten while on engine, as binding may damage bridge, guide, and valve.

7. Apply engine oil to bridge and bridge guide.
8. Reinstall the bridge in its original position.

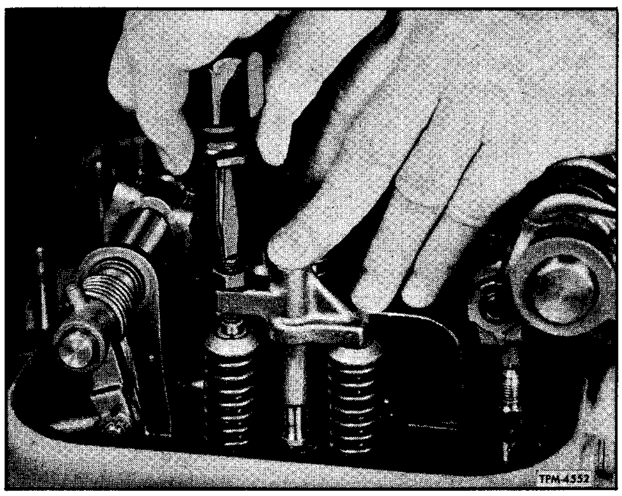


Figure 1—Adjusting Valve Bridge (71 Series)

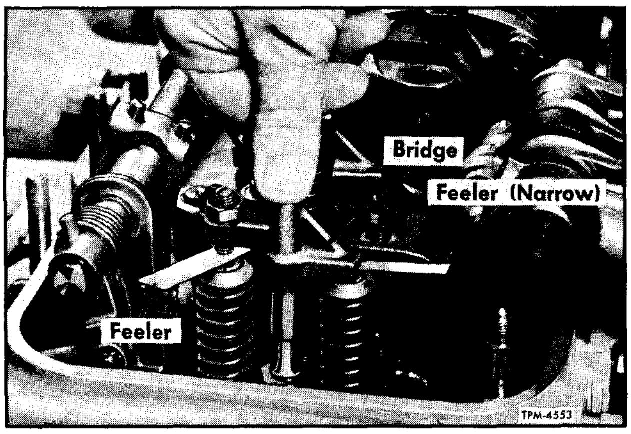


Figure 2—Valve Bridge Adjustment Check (71 Series)

9. Place a 0.0015" feeler under each end of the bridge (fig. 2).

NOTE: Feeler used at inner end of bridge must be narrow enough to fit in bridge locating groove. Pressing down on the pallet surface of the bridge, both feelers must be tight. If both feelers are not tight, readjust the screw as previously instructed.

10. Adjust remaining bridges as instructed in previous paragraphs.

NOTE: If cylinder head has been removed, reinstall on the engine. Tighten cylinder head stud nuts to their specified torque before assembling the rocker shaft brackets to the head. This precaution is necessary to prevent valve damage due to mislocating bridges.

11. Install the rocker arm shaft and rocker arm assemblies, being sure valve bridges are properly positioned on the inner valve stems.

12. Tighten rocker shaft bracket bolts to their recommended torque 90 to 100 foot-pounds.

13. Reconnect fuel lines to injectors and connectors. Torque 12 to 15 foot-pounds with adapter socket (J-8932).

ADJUST EXHAUST VALVE CLEARANCE

All valves may be lashed in firing order sequence during one full revolution of the crankshaft

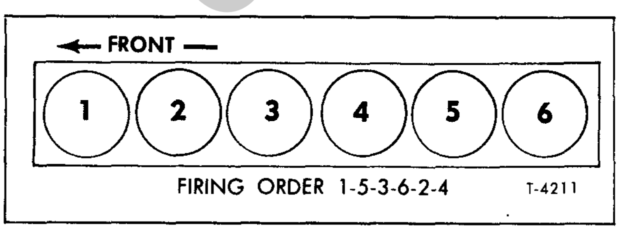


Figure 3—Cylinder Numbering and Firing Order (In-Line 6 Cylinder Engine)

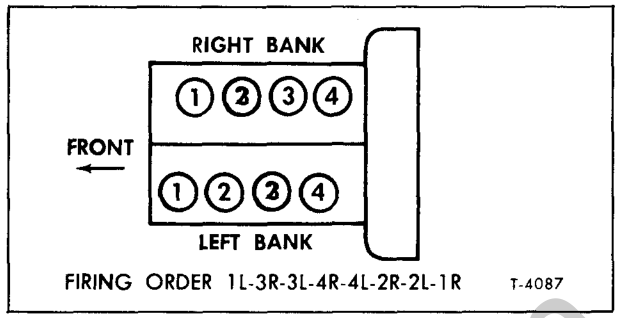


Figure 4—Cylinder Numbering and Firing Order (8V-71 Engine)

(figs. 3 and 4). When the cylinder head has been installed valve lash adjustment must always be made with the engine COLD. This setting should result in proper clearance at normal engine operating temperature. Use a 0.017-inch feeler gauge (J-9708) between the valve bridge and rocker arm as shown in figure 5, if engine is cold or use 0.015-inch feeler gauge if engine is hot.

IMPORTANT: Temperature of 160^{o} to 185^{o}F. is considered "hot" engine. When checking valve clearance with engine "hot" the procedure must be accomplished before allowing engine to become cold (below 160^{o}F.).

1. Clean loose dirt from exterior of the engine and remove the valve rocker covers. Use new gaskets if necessary when installing the valve rocker covers.

2. Place governor throttle control lever in the "NO-FUEL" position.

3. Rotate crankshaft until the injector follower is fully depressed on the cylinder being adjusted.

4. Loosen valve push rod lock nut.

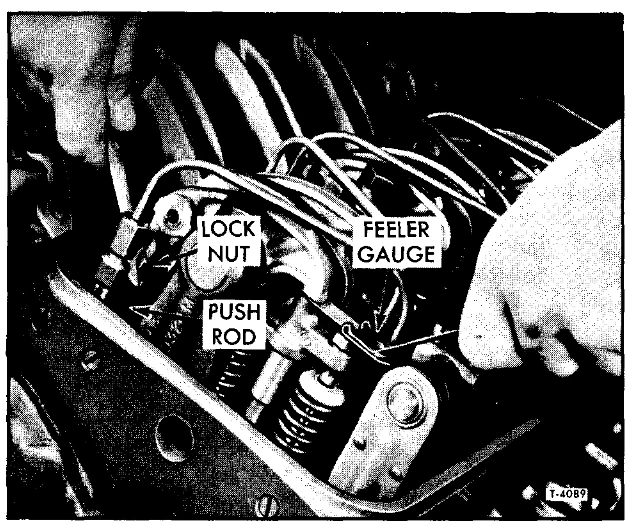


Figure 5—Adjusting Valve Clearance (Typical)

NOTE: VALVE LASH MUST ALWAYS BE ADJUSTED AT THE PUSH ROD. DO NOT DISTURB BRIDGE ADJUSTING SCREW.

5. When engine is cold place 0.017" feeler gauge (fig. 5) between bridge and rocker arm. Adjust push rod to obtain a smooth "pull" on the feeler gauge.

6. Remove feeler gauge. Hold push rod with wrench and tighten push rod lock nut with ½-inch wrench.

7. Recheck clearance at each valve bridge. If adjustment is correct with "cold" engine, a 0.015-inch feeler gauge will pass freely between rocker arm and valve bridge, but 0.017-inch feeler gauge will not pass through. If engine is "hot" when recheck is made, a 0.013-inch feeler gauge should pass freely between rocker arm and valve bridge, but a 0.015-inch feeler will not pass through. Readjust push rod if necessary.

8. Check and adjust remaining valves in manner described in previous paragraphs.

9. With engine at operating temperature (160°F. to 180°F.), recheck clearances. Readjust push rod if necessary.

TIME FUEL INJECTORS

To properly time the injector, the injector follower-guide must be adjusted to a definite height. Refer to figure 6 for reference to the following operation. All injectors can be timed during one full revolution of the crankshaft.

NOTE: The engine must be at normal operating temperature.

1. Set governor control lever in the "NO-FUEL" (off) position.

2. Turn engine crankshaft manually or by means of the starter, until the exhaust valve rocker arms are fully depressed, for that particular cylinder.

IMPORTANT: If a wrench is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation as the bolt will be loosened.

3. The injector is identified by a colored tab stamped onto the injector body. Injector is timed with gauge listed in chart following.

4. Place the injector timing gauge in the hole provided on top of the injector body with one of the "flats" toward the injector.

5. Adjust the injector rocker arm by loosening lock nut and turning the push rod with an end wrench, until the bottom of the timing gauge head will just pass over (drag lightly) the top of the injector follower guide.

NOTE: Turning or spinning the timing gauge lightly with the finger tips will make it easier to determine the injector follower height and prevent cocking the gauge.

6. Hold push rod from turning and tighten lock nut. Recheck adjustment with injector timing gauge and readjust if necessary.

7. Time the remaining injectors as outlined in Steps 1 through 6.

NOTE: It is important that all the injectors be set at the same height for best engine performance.

Camshaft timing on In-line and 8V engines equipped with the optional N65 injectors, has been advanced one tooth (identified by "A" stamped on the serial number pad of the cylinder block). When checking or setting injector timing of engine models covered by this manual and to ensure proper injector timing for the various combinations of camshaft timing and N65 injectors, the following chart should be consulted:

Injector Type	Camshaft Timing	Injector Timing
White Tag	Standard	1.460
White Tag	Advanced	1.460
Brown Tag	Standard	1.460
Brown Tag	Advanced	1.484
Mixed White & Brown Tag	Standard	White 1.460 Brown 1.460
Mixed White & Brown Tag	Advanced	White 1.460 Brown 1.484

NOTE: Injector Timing Tool J-1242 - 1.484.
Injector Timing Tool J-1853 - 1.460.

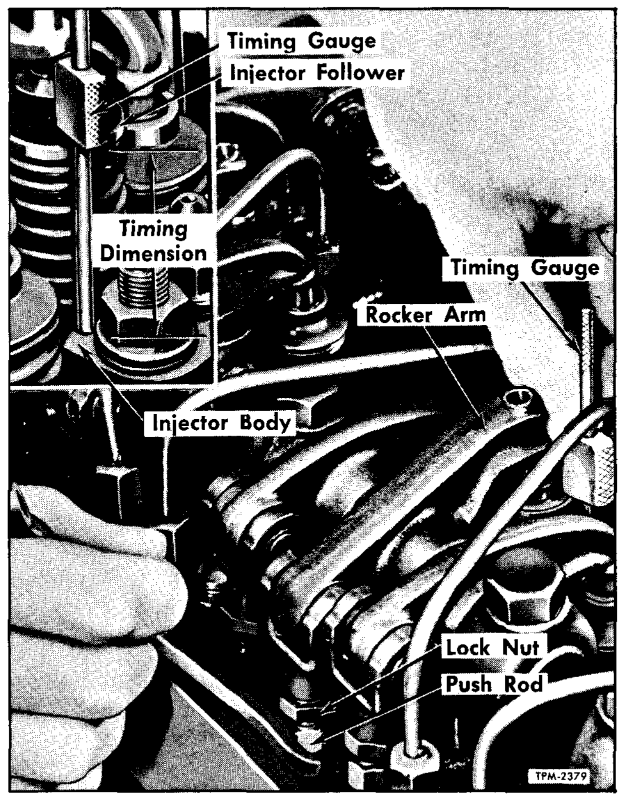
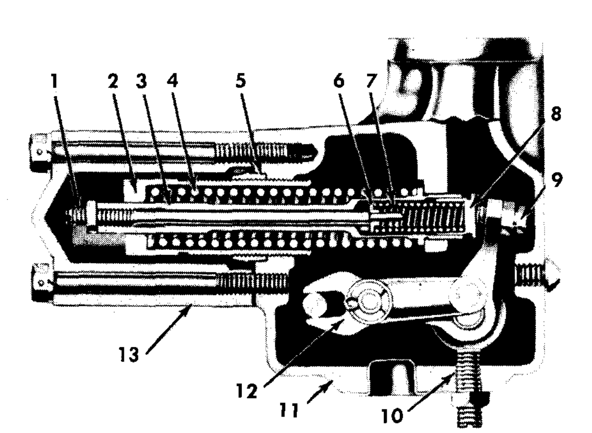


Figure 6—Timing Fuel Injector (Typical)



1 Idle Speed Adjustment Screw
2 High Speed Spring Retainer
3 High Speed Spring Plunger
4 High Speed Spring
5 Retainer Lock
6 Low Speed Spring Seat
7 Low Speed Spring
8 Spring Cap
9 Gap Adjustment Screw
10 Buffer Screw
11 Governor Housing
12 Differential Lever
13 Spring Housing T-4587

Figure 7—Governor Springs and Levers (In-Line Engine)

A method of checking injector follower height is described below:

With the rocker arm covers removed, the engine at normal operating temperature and running at normal idle, place the small end of the injector timing gauge in the hole provided in the top of the injector body as shown in figure 6.

IMPORTANT: Since the engine is running, do not leave timing tool in injector body with engine running. Do not attempt to adjust or time injector with engine running as injector plunger could bottom and damage injector and operating mechanism.

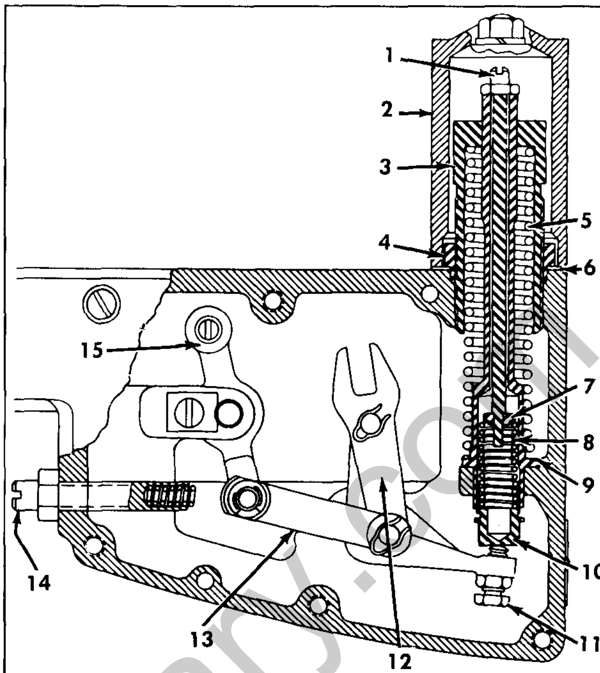
When injector is properly set, by rotating or spinning timing tool with finger tips the height of the follower can just be felt. If the follower is too low it cannot be felt. When the follower is too high it will bump the tool and should be reset so all injectors are the same height.

ADJUST GOVERNOR GAP

Governor used on these engines is a limiting speed double weight type which controls the injector control rack. Ordinarily this adjustment is necessary only when governor assembly is repaired or replaced. When necessary to check or adjust proceed as follows:

The following tune-up adjustments must be performed in sequence given, but not until valves and injectors are in proper adjustment as previously described.

The desirable idling speed is 400 to 450 rpm. To properly adjust governor gap it is necessary for engine to be at normal operating temperature and idle speed screw adjusted 15 rpm below final setting.



1 Idle Speed Adjustment Screw
2 Spring Housing
3 High Speed Spring Retainer
4 Retainer Lock
5 High Speed Spring
6 Gasket
7 Low Speed Spring Seat
8 Low Speed Spring
9 High Speed Spring Plunger
10 Spring Cap
11 Gap Adjustment Screw
12 Differential Lever
13 Connecting Link
14 Buffer Screw
15 Operating Lever T-4586

Figure 8—Governor Springs and Levers (V8-71 Engine)

1. Remove two bolts and lock washers attaching governor spring housing (13, fig. 7 or 2, fig. 8) to control housing.

2. Loosen lock nut and turn buffer screw out slightly (10, fig. 7 or 14, fig. 8).

IMPORTANT: The buffer screw must be adjusted with caution, since it contacts the connecting link, and turning the buffer screw in causes injectors to go toward full fuel position.

3. Start engine and operate at idle speed while observing rpm at tachometer.

NOTE: It may be necessary to slightly adjust buffer screw in to take the surge or roll from the engine to stabilize idle speed for accurate setting. DO NOT RAISE ENGINE SPEED ABOVE IDLE SPEED SETTING BY TURNING BUFFER SCREW IN.

4. If necessary to adjust, loosen lock nut and turn idle adjusting screw (1, fig. 7 or 1, fig. 8) IN

to increase or OUT to decrease speed. Lock adjusting screw with lock nut when idle speed is approximately 15 rpm below desired setting.

5. Turn buffer screw OUT until screw projects about 5/8" beyond lock nut.

6. Disconnect throttle and stop linkage at governor cover. Remove governor cover and gasket.

WARNING: DO NOT OVER-SPEED ENGINE AS GOVERNOR IS NOW DISCONNECTED AND CANNOT CONTROL ENGINE SPEED.

a. On In-line, engine remove connecting link between governor by removing hairpin clip and washer and pin at control tube lever. Start engine, then by hand, move control tube so as to operate engine at approximately 700 to 800 rpm.

b. On V8 engines, start engine and run engine at 800-1,000 rpm by manual operation of differential lever.

NOTE: A shop towel can be placed over part of governor housing to prevent splash of oil.

7. With engine running at specified rpm, measure gap between low speed spring cap and plunger (fig. 9). If there is not a slight drag on a 0.0015" feeler gauge loosen lock nut and turn adjusting screw until desired gap is obtained, then tighten lock nut. Recheck gap after tightening lock nut.

8. Stop the engine.

a. On In-line engine, install connecting link between governor and injector control tube lever. Install control housing cover and gasket, being sure that throttle shaft pin engages differential lever fork, and that the stop lever will release the control rack to "NO-FUEL" position. Install four cover screws and washers.

b. On V8 engines, remove shop towel, install governor cover and gasket, being sure that throttle shaft pin engages differential lever fork and that the stop lever will release the control racks to "NO-FUEL" position. Install cover screws and washers.

IMPORTANT: If governor cover is not properly installed there will be no control of the engine and serious damage can occur.

POSITION INJECTOR RACK CONTROL LEVERS

The position of the injector racks must be correctly set in relation to the governor and with the engine at normal operating temperature. Properly positioned injector rack control levers with the engine at "FULL-LOAD" will result in the following:

1. Speed control lever at the maximum speed position.

2. Governor low speed gap closed.

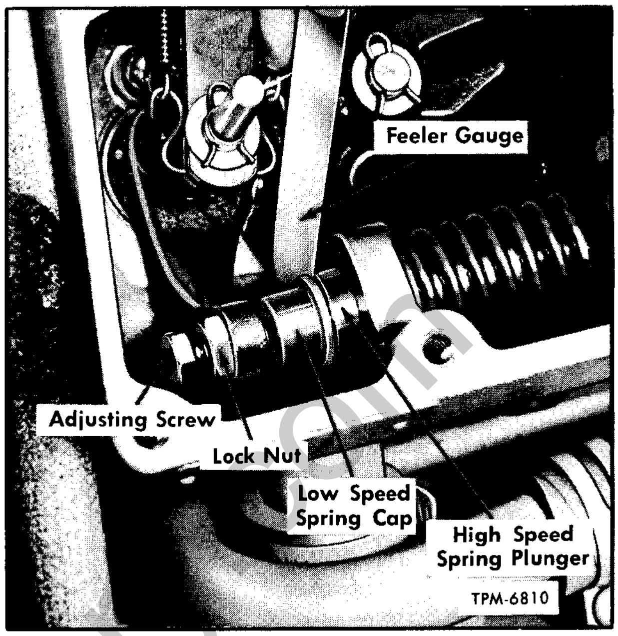


Figure 9—Low Speed Spring Gap Adjustment (Typical)

3. High speed spring plunger on the seat in the governor control housing.

4. Injector fuel control racks in the "FULL-FUEL" position.

NOTE: Refer to figure 3 or 4 for cylinder numbers.

a. Disconnect the linkage attached to the speed control lever, if not previously done.

b. On V8 engines, turn the idle speed adjusting screw so that about ½" of the screw projects from the lock nut.

NOTE: This adjustment lowers the tension of the low speed spring so it can be compressed, while closing the low speed gap, without bending the fuel rods.

c. Back out the buffer screw approximately 5/8" and remove valve rocker cover, if it has not already been done.

d. Loosen all the inner and outer injector rack control lever adjusting screws on In-line engine and both injector control tubes on V8 engine. Be sure all the injector rack control levers are free on the injector control tubes, and that the injector rack control levers are not binding.

e. Move the speed control lever to the maximum speed position; hold it in that position with light finger pressure. Turn the inner adjusting screw on the No. 1 cylinder (fig. 3) on In-line engines and No. 1L cylinder (fig. 4) on V8 engines injector rack control down as shown in figure 10 or 11, until a slight movement of the control tube lever is observed or a step-up in effort to turn the screwdriver is noted. This will place No. 1 or 1L injector in the "FULL-FUEL" position. Turn down

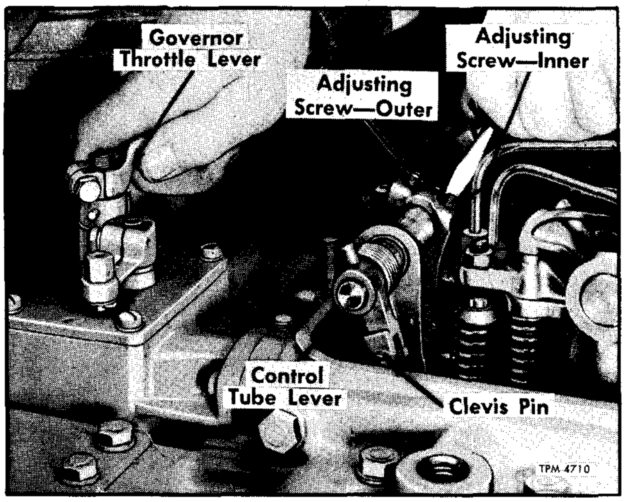


Figure 10—Injector Control Rack Adjustment (In-Line Engine)

the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both the inner and outer adjusting screws.

NOTE: The above step should result in placing the governor linkage and control tube assembly in the same positions that they will attain while the engine is running at full-load.

f. To be sure of the proper rack adjustment, the following check should be performed:

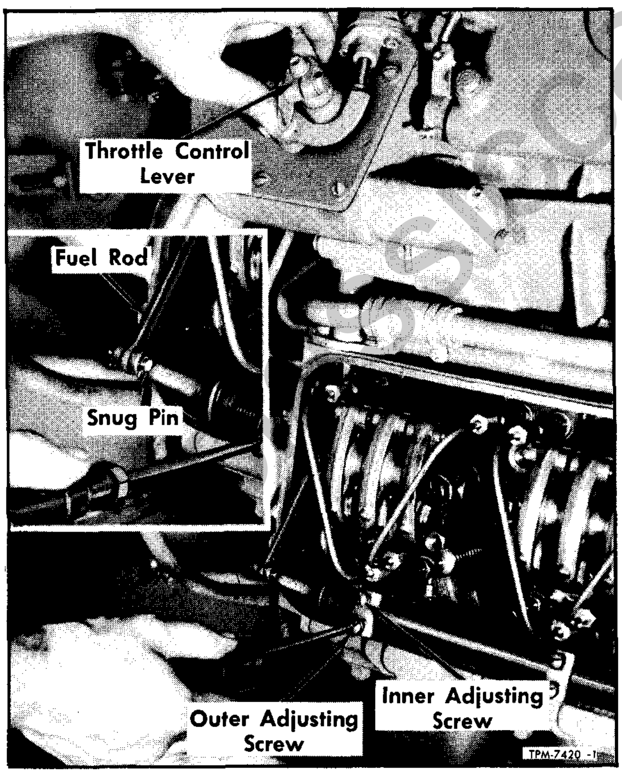


Figure 11—Injector Control Rack Adjustment (V Engine)

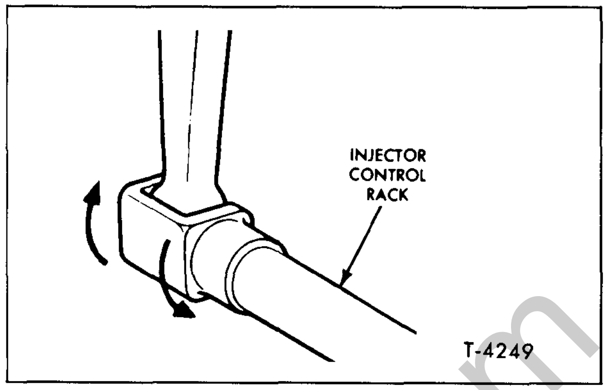


Figure 12—Checking Rotating Movement of Injector Rack

(1) Move the speed control lever back and forth a few times and note a "rotating" movement of the injector control rack (fig. 12) when the speed control lever is moved to the maximum speed position.

(2) Hold the speed control lever in the maximum speed position and, using a screwdriver, or finger tips press downward on the injector control rack (fig. 13). The rack should then tilt downward and when the pressure of the screwdriver is released, the control rack should "spring" back upward.

NOTE: The setting is sufficiently tight if the rack returns to its original position. If the rack does not return to its original position, it is too loose.

(3) To correct this condition, back off the outer adjusting screw slightly and tighten the inner adjusting screw.

NOTE: The setting is too tight if, when moving the speed control lever from the idle to the maximum speed position, the injector rack becomes tight before

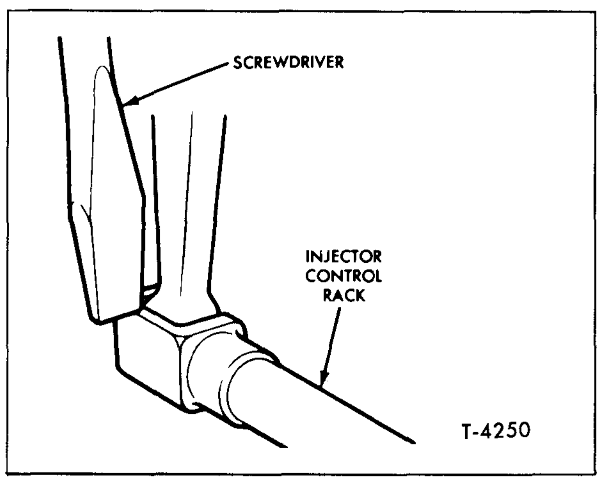


Figure 13—Checking Injector Rack Spring

the speed control lever reaches the end of its travel (stop under the governor cover). This will result in a slight step-up in effort required to move the speed control lever to its maximum speed position and a deflection in the fuel rod (fuel rod deflection can be seen at the bend).

(4) If the rack is too tight, back off the inner adjusting screw slightly and tighten the outer adjusting screw.

NOTE: After the No. 1 on 6-71, or 1L and 1R on V8 engine, injector rack control lever is correctly set, it must not be changed throughout the adjustment of the remaining injector rack control levers, since it is set to the governor.

g. On V8 engines, position the 1R cylinder as described in Steps e and f previously. Repeat the check on 1L and 1R as outlined in Step f.

NOTE: Both injector control racks (1L and 1R) should be the same.

h. With governor control lever held in "FULL-FUEL" position, note rotary movement of No. 1 or 1L and 1R on V8 engine injector rack to lever coupling. Pressure of finger tip will produce a tendency to rotate, but coupling should not be loose. All remaining injector rack control levers must now be adjusted to the same "feel" at coupling to ensure same amount of fuel injected into each cylinder at "FULL-LOAD" as follows:

NOTE: On V8 engines after 1L and 1R have been set so they are alike the remainder of injector control racks on either cylinder head can be adjusted from the front to the rear. On In-line engine after No. 1 is properly set the remaining can be set from front to rear.

i. Hold governor control lever in "FULL-FUEL" position. Adjust No. 2 injector rack control lever 2L or 2R on V8 engine by turning down inner adjusting screw until the injector rack has moved to "FULL-FUEL" position. This can be noticed as the coupling picks up. Turn the outer adjusting screw until it bottoms lightly on the injector control tube. Then alternately tighten both inner and outer adjusting screws.

NOTE: When the settings are correct the racks of the injectors must be snug and the same tension on the ball end of their respective rack control levers when checked with screwdriver or fingers (figs. 12 and 13).

j. Recheck the No. 2 and No. 1 injector rack couplings on In-line engine with screwdriver or finger tip to check rotary movement, or recheck the 2L and 1L on V8 engine.

k. If No. 1 injector rack coupling now feels loose, No. 2 injector rack coupling is too tight. Correct No. 2 injector rack adjustment by loosening inner adjusting screw and tightening outer adjusting screw.

l. If No. 2 injector rack coupling feels loose, correct by loosening outer adjusting screw slightly and tighten inner adjusting screw.

m. When No. 2 injector rack coupling "feels" the same as No. 1, repeat this procedure (operations h, i, j, k, and l) on all remaining injector racks. That is, compare No. 3 injector rack coupling with No. 1, etc., until all control racks are properly adjusted.

NOTE: An accurate rack setting in "FULL-FUEL" position will result in balanced injection throughout the entire operating range. Therefore, a "rough" idle after tune-up calls for a check of governor, injectors and related controls. Do not attempt to change rack position with engine idling or operating at any position with engine idling or operating at any speed. When one rack is adjusted "in" more than the others, only that one injector rack can reach "FULL-FUEL" position. As a result, maximum output of the engine will be reduced.

n. On V8 engines, turn the idle speed adjusting screw in until it projects 3/16" from lock nut to permit starting engine (fig. 14).

o. Connect throttle and stop linkage to governor cover, making sure it is properly adjusted as described in ENGINE FUEL SYSTEM (6M) of this manual.

p. Install rocker arm cover and gasket.

ADJUST MAXIMUM NO-LOAD SPEED

After positioning the injector rack control levers, set the maximum engine speed as follows:

NOTE: Be sure the buffer screw projects 5/8" from the lock nut to prevent interference while adjusting the maximum no-load speed.

1. Loosen the high speed spring retainer lock nut (fig. 15), using a spanner wrench.

2. With the engine running at operating temperature and no-load on the engine, place the speed

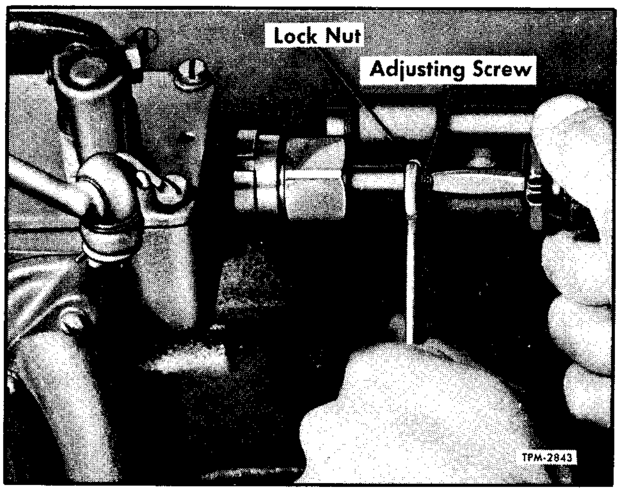


Figure 14—Idle Speed Adjustment (Typical)

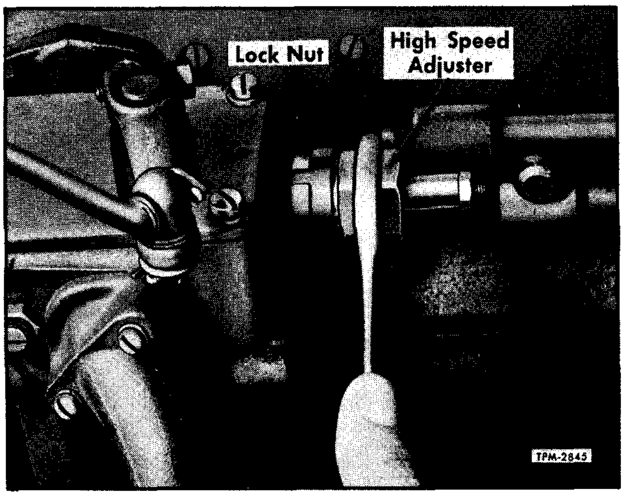


Figure 15—Adjusting No-Load High Speed

control lever in the maximum speed position. Turn the high speed spring retainer until the engine is operating at the recommended no-load speed. See "Specifications" at end of this section.

3. Turn high speed adjuster IN to increase, or OUT to decrease speed (fig. 15) until desired no-load setting is obtained.

4. Hold adjuster, then tighten lock nut, using spanner wrench.

5. Recheck and if necessary readjust after tightening lock nut.

ADJUST IDLE SPEED

The engine must be at operating temperature when making final idle speed adjustment.

1. Start engine and operate at idle speed while observing rpm at tachometer.

IMPORTANT: It may be necessary to turn buffer screw in to reduce surge or roll in engine. Do not increase engine rpm with buffer screw.

2. If necessary to adjust, loosen lock nut and turn idle adjusting screw IN to increase or OUT to decrease (fig. 14). Lock adjusting screw with lock nut when idle speed is approximately 15 rpm below desired setting.

BUFFER SCREW ADJUSTMENT

On vehicles equipped with engine brake system, the adjustment of the buffer screw itself remains the same, but to remove and replace the

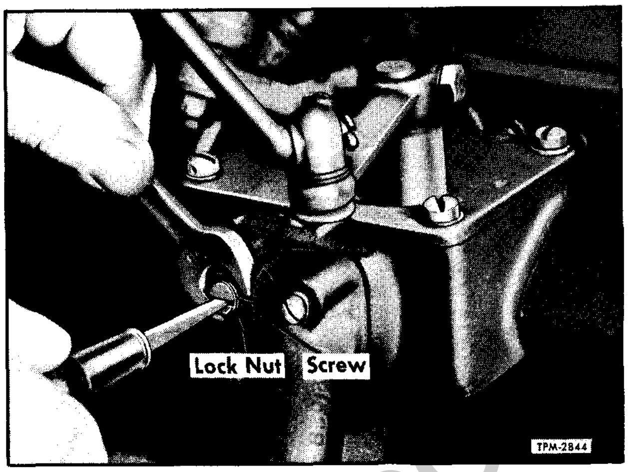


Figure 16—Adjusting Buffer Screw (Typical)

brake switch at the governor, in order to make buffer screw adjustment refer to "Engine Brake" later in this section.

With the idle speed set, the buffer screw may be adjusted as follows:

1. With the engine running at normal operating temperature, turn the buffer screw (fig. 8) in so that it contacts the differential lever as lightly as possible and still eliminates the engine roll (fig. 16).

NOTE: Do not increase the engine idle speed more than 15 rpm with the buffer screw.

2. Buffer screw can be checked for proper adjustment by accelerating engine and de-accelerating. When engine comes to idle from de-acceleration it should roll one to two times and level off to smooth idle.

If engine rolls or surges more than three times, the buffer screw needs to be adjusted in slightly.

If engine does not roll one to two times, the buffer screw is adjusted in too far.

3. With buffer screw properly adjusted, hold the buffer screw and tighten the lock nut and recheck.

4. Recheck the maximum no-load speed. If it has increased more than 25 rpm, back off the buffer screw until the increase is less than 25 rpm.

5. Install governor spring housing assembly to governor housing and secure with two bolts and lock washers.

Diagnosis and Troubleshooting Section contained on pages 6C-49 through 6C-62 in this manual, may be used in diagnosing and correcting engine malfunctions in diesel engine models.

DIESEL ENGINE TUNE-UP CHARTS

Charts which follow list data required for performing Tune-Up Operations on In-Line, 6-Cylinder and 8V-71 Series engines. Refer to page 426 for Tune-Up Chart on 53 Series Diesel engines.

NOTE: If engine is equipped with an engine brake, refer to Maintenance Procedure covered later in this section for servicing the engine brake mechanism.

ENGINE TUNE-UP CHART
6-71NE & 6-71N

ENGINE TYPE .... 6-71NE & 6-71N (2 Stroke Cycle)
NUMBER OF CYLINDERS 6
CYLINDER NUMBERING .... (See Figure 3)
FIRING ORDER 1-5-3-6-2-4
VALVE LASH
- Hot .... 0.013" Go, 0.015" No Go
- Cold .... 0.015" Go, 0.017" No Go

CYLINDER HEAD BOLT TORQUE .... 190-200 Ft. Lbs.*
ENGINE *IDLE SPEED* .... 400-450 RPM
ENGINE GOVERNED SPEED (Full Load) Note 1
- 6-71NE .... 1950 RPM
- 6-71N .... 2100 RPM

FUEL INJECTOR TYPE
- 6-71N .... N60 or N65
- 6-71NE N55

INJECTOR VALVE OPENING PRESSURE .... 2000-3200 PSI
COMPRESSION RATIO 18.7:1
CYLINDER COMPRESSION (Min.) .... 515 PSI**

INJECTION TIMING DIMENSION
- (Except opt. N65 Injector) .... 1.460"
- (Opt. N65 Injector) .... 1.484"***

FUEL SUPPLY PUMP
- Capacity (at 1500 engine RPM) .... 90 Gal. Per Hr.
- Relief Valve Opens (Approx) .... 70 PSI

*Threads and bolt heads coated with international compound #2 part number 5198563 or equivalent.

**At sea level, with engine running at 600 RPM. Variation between cylinders not to exceed 25 PSI.

***Camshaft timing on inline 6 and 8V engines equipped with the optional N65 injectors is advanced one tooth (identified by "A" stamped on the serial number pad of the cylinder block). When checking or setting these injectors, use timing tool J-1242 with 1.484" dimension instead of J-1853 as used on all other injectors.

Note 1: No-load governed speed is approximately 150 RPM more than full-load speed.

ENGINE TUNE-UP CHART
(8V-71N & 8V-71NE)

ENGINE TYPE .... 2 Stroke Cycle
NUMBER OF CYLINDERS 8
CYLINDER NUMBERING .... (See Figure 4)
FIRING ORDER 1L-3R-3L-4R-4L-2R-2L-1R
VALVE LASH
- Hot .... 0.013" Go, 0.015" No Go
- Cold .... 0.015" Go, 0.017" No Go

CYLINDER HEAD BOLT TORQUE .... 190-200 Ft. Lbs.*
ENGINE IDLE SPEED .... 400-450 RPM
ENGINE GOVERNED SPEED (Full Load) Note: 1
- 8V-71N .... 2100 RPM
- 8V-71NE .... 1950 RPM

FUEL INJECTOR TYPE
- 8V-71NE N55
- 8V-71N .... N60 or N65

INJECTOR VALVE OPENING PRESSURE .... 2000-3200 PSI
COMPRESSION RATIO 18.7:1
CYLINDER COMPRESSION (Min.) .... 515 PSI**

INJECTION TIMING DIMENSION
- (Except opt. N-65 Injector) .... 1.460"
- (Opt. N65 Injector) 1.484***

FUEL SUPPLY PUMP
- Capacity (at 1500 engine RPM) .... 90 Gal. Per Hr.
- Relief Valve Opens (Approx.) .... 70 PSI

*Threads and bolt heads coated with international compound #2 part number GM 5198563 or equivalent.

**At sea level, with engine running at 600 RPM. Variation between cylinders not to exceed 25 PSI.

***Camshaft timing on inline 6 and 8V engines equipped with the optional N65 injectors is advanced one tooth (identified by "A" stamped on the serial number pad of the cylinder block). When checking or setting these injectors, use timing tool J-1242 with 1.484" dimension instead of J-1853 as used on all other injectors.

Note 1: No-load governed speed is approximately 150 RPM more than full-load speed.

ENGINE REPLACEMENT (CONVENTIONAL AND TILT CAB MODELS)

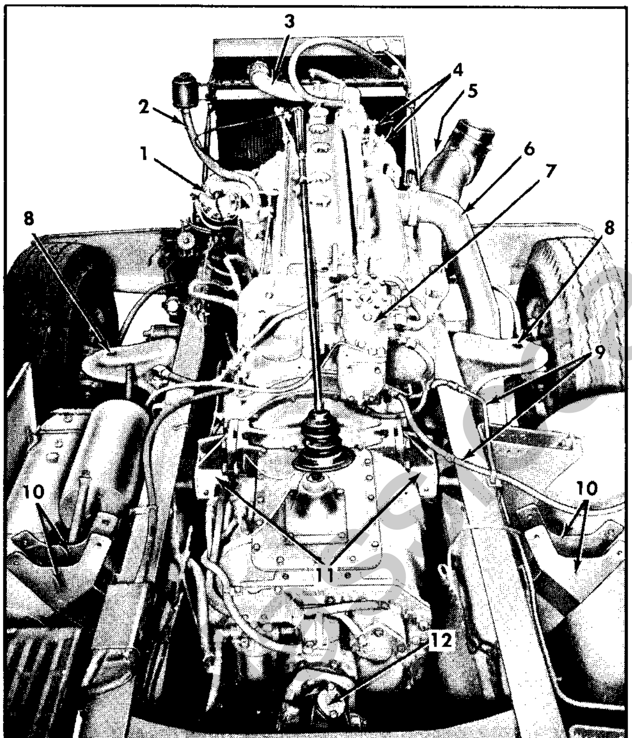
GENERAL

The procedure required to replace the engine is given separately for vehicles with In-line, and with V-type engines.

Procedures can be used as a guide as to logical sequence for performing usual work required with commonly used equipment. The mechanic, by observation, can determine what additional work is required for removing various R.P.O. equipment items.

CAUTION

Only personnel familiar with air conditioning service procedures should attempt removal and/or installation of air conditioning units.



1 Generator	8 Cab Front Mounting Bracket
2 Power Steering Reservoir Tube	9 Fuel Lines
3 Radiator Hose	10 Cab Rear Mounting Brackets
4 Governor Levers	11 Engine Rear Mountings
5 Blower Air Inlet	12 Propeller Shaft
6 Exhaust Pipe	
7 Air Compressor	

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Figure 17—Installation of In-Line Diesel Engine in Conventional Model (Typical)

Refer to pertinent sections of this manual for additional information regarding items involved in engine removal.

The procedure required to replace a power plant varies with the type of engine, design of vehicle, and equipment installed. Figure 17 is a typical view of In-line diesel power plant installation in Conventional type cab model. The items identified in the illustration are common to most trucks having 2-cycle Diesel engines.

On Tilt cab vehicles, a removable control island is bracket-mounted over the engine.

IN-LINE DIESEL ENGINE REMOVAL

CONVENTIONAL CAB MODELS

1. Disconnect battery cables to prevent short circuits while working on engine.
2. Disconnect cables and ground strap from starter.
3. Disconnect wiring at terminals and multiple wire connectors on cab.
4. Drain cooling system. Disconnect air lines from compressor.
5. Refer to applicable portions of CAB AND BODY (SEC. 1) of this manual, and remove cab from vehicle. If vehicle is equipped with power steering, disconnect fluid lines, or remove the power steering pump from engine with fluid lines attached.
6. Disconnect propeller shaft from rear of transmission, and remove fan blades at front of engine.
7. Disconnect fuel supply and return lines from engine fittings.
8. Disconnect the exhaust pipe from the manifold.
9. Disconnect and remove radiator and heater hoses.
10. Position overhead hoist above power plant and attach hoist chains to lifting eyes provided on engine. Raise the hoist until the chains are tight, then remove mounting bolts at front and rear mountings. If a support is used at rear of the transmission, remove bolts to permit power plant removal.
11. Lift power plant out of chassis and mount on dolly or repair cradle.
12. Refer to TRANSMISSIONS AND CLUTCHES (SEC. 7) in this manual, for necessary instructions for removing the transmission and clutch from the engine.

IN-LINE DIESEL ENGINE INSTALLATION

CONVENTIONAL CAB MODELS
(Refer to Fig. 17)

1. Refer to TRANSMISSIONS AND CLUTCHES (SEC. 7) for necessary information to install clutch and transmission on engine.
2. Attach overhead hoist to power plant. Lifting brackets are provided on engine. Lift the power plant into position in chassis and install mounting bolts. Also assemble support at transmission (if used). Refer to ENGINE MOUNTINGS (SEC. 6D) for correct bolt torque on engine mounting bolts.
3. Reverse the "Engine Removal" procedures to connect hoses, electrical wiring, fuel lines, controls, etc.
4. Install cab, referring to CABS AND BODIES (SEC. 1) for necessary information for assembling cab mountings and fitting sheet metal parts.
5. Check for leaks in cooling system and for oil leaks after starting engine and making adjustments.

V-TYPE DIESEL ENGINE REMOVAL

CONVENTIONAL CAB MODELS

1. Drain the cooling system, and disconnect the battery.
2. Remove front fender, hood, and grille assembly.
3. Remove floor pan from cab.
4. Disconnect air inlet hose and remove air cleaner.
5. Disconnect exhaust pipes and remove left-hand exhaust manifold to provide clearance past the steering shaft.
6. Disconnect engine controls and all electrical wiring.
7. Disconnect clutch hydraulic line; or remove clutch release cylinder attaching bolts and leave the cylinder line attached.
8. Remove radiator hoses and heater hoses, then remove radiator and shroud assembly. Remove fan blades to avoid damaging during engine removal.
9. Remove power steering pump and bracket and allow fluid lines to remain attached.
10. Disconnect tachometer drive (if used).
11. If vehicle is equipped with auxiliary transmission, remove tower and lever from inside cab.
12. Disconnect propeller shaft and speedometer drive at rear of main transmission. Remove gearshift lever from main transmission.
13. Attach overhead hoist to lifting brackets on engine. While supporting power plant on hoist, remove engine front mounting and bracket. Disconnect engine rear mounting, then raise power plant and move forward to remove from vehicle.

V-TYPE DIESEL ENGINE INSTALLATION

CONVENTIONAL CAB MODELS

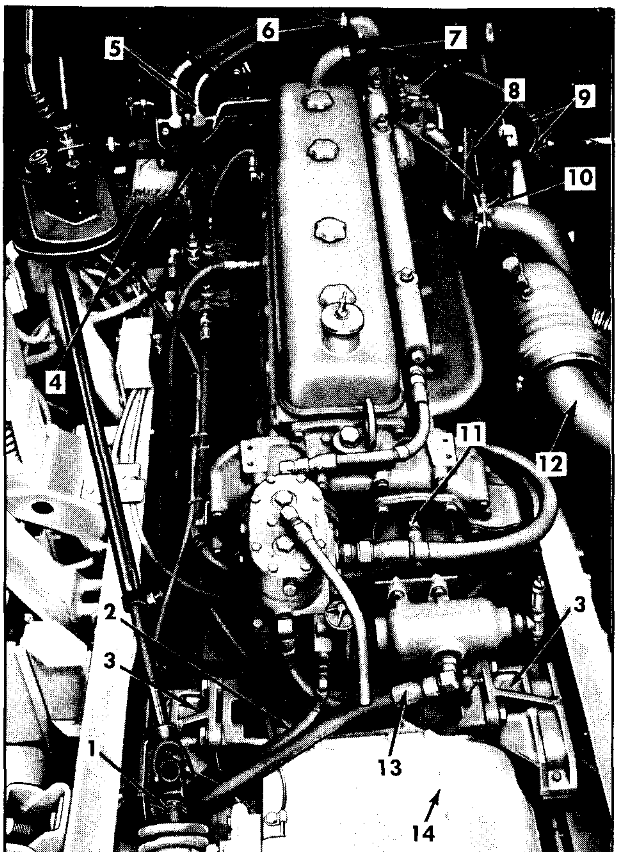
1. Refer to TRANSMISSION AND CLUTCHES (SEC. 7) in this manual for required information, and install clutch and transmission on engine.
2. Raise power plant with hoist and position in chassis. Assemble engine mounting parts and refer to ENGINE MOUNTINGS (SEC. 6D) in this manual for arrangement of parts and correct torque specifications on mounting bolts. Also assemble support (if used) at transmission.
3. Reverse the "Engine Removal" procedures to connect wiring, fuel lines, engine and clutch controls, etc.
4. Install fan blades, radiator and shroud assembly, and connect exhaust pipes.
5. Fill cooling system and add oil to bring crankcase oil level to "F" on dipstick.
6. Start engine and check for leaks in cooling system and for oil leaks.
7. Install floor pan in cab. Install front fender, hood, and grille assembly.

IN-LINE DIESEL ENGINE REMOVAL

(Refer to Figure 18)

TILT CAB MODELS

1. Tilt cab fully forward, secure with safety pin, and disconnect cables from battery.
2. Drain cooling system.
3. Open drain cock at air compressor discharge muffler to exhaust air from air system.
4. Close valves at cooling system water filter and disconnect lines from engine.
5. Disconnect fuel supply and return lines.
6. Disconnect transmission controls.
7. Disconnect engine controls and any wiring necessary for engine removal.
8. Disconnect radiator upper and lower hose.
9. Remove front oil filler pipe and dipstick tube.
10. Disconnect and remove air inlet pipe between air cleaner and blower housing.
11. Disconnect exhaust pipe from exhaust manifold.
12. Disconnect air discharge line and air compressor governor line.
13. Disconnect speedometer drive at rear of transmission. Also disconnect transmission control air lines and wiring as required.
14. If transmission has a rear support, remove the support mounting bolts.
15. Disconnect tachometer drive from adapter at rear of engine.
16. Disconnect propeller shaft at rear of transmission.
17. On vehicles with air conditioning, remove



1 Transmission Control
2 Air Pressure Line
3 Engine Rear Mounting
4 Alternator
5 Refrigerant Lines (With Air Conditioning)
6 Radiator Upper Hose
7 Oil Filler Tube
8 Dipstick Tube
9 Coolant Hose (To Water Filter)
10 Exhaust Pipe
11 Tachometer Drive
12 Air Inlet Hose (To Blower Housing)
13 Compressed Air Discharge Line
14 Transmission

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Figure 18—6-71 Diesel Engine Installed (Tilt Cab) (Typical)

refrigerant compressor drive belt, remove compressor with lines connected. Secure the compressor in manner to prevent interference when removing engine.

18. When so equipped, remove power steering pump from engine and tie the pump (with fluid lines connected), to frame in a manner to prevent interference when removing engine.

19. Remove caps from engine rear mounting brackets.

20. Vehicles with air conditioning.

Remove the two bolts and washers which attach right and left front engine mountings to crossmember.

21. Vehicles without air conditioning.

a. Remove drive pulley and damper from front end of crankshaft.

b. Remove bolts and washers which attach engine front support to frame crossmember.

c. With front end of engine raised and securely blocked, remove bolts which attach front support to front mounting cushions and remove front support.

22. Attach overhead lifting equipment and raise power plant assembly. Check all lines, wiring, or controls to be sure all have been disconnected, then remove power plant.

23. If it is necessary to remove transmission and clutch, refer to appropriate portion in TRANSMISSIONS AND CLUTCHES (SEC. 7) of this manual for procedures.

IN-LINE ENGINE INSTALLATION

(Refer to Figure 18)

TILT CAB MODELS

1. Install clutch, transmission, and trim items on engine, referring to appropriate sections in this manual for necessary instructions.

2. Install power plant in chassis by reversing the "Removal" procedures previously given.

NOTE: Refer to ENGINE MOUNTINGS (SEC. 6D) in this manual for bolt torque and other information regarding mounting parts.

3. After all equipment has been installed, fill cooling system, engine crankcase, and power steering reservoir (if used). Also check transmission lubricant level.

4. Start engine, make necessary adjustments and check for leaks.

V-TYPE ENGINE REMOVAL (TILT CAB MODELS)

(Refer to Figure 19)

1. Tilt cab fully forward, secure with safety pin, and disconnect cables from battery terminal.

2. Drain cooling system.

3. Open drain cock at air compressor discharge muffler to exhaust air from air system.

4. Close valves at cooling system water filter and disconnect lines from engine.

5. Disconnect fuel supply and return lines.

6. On vehicles with power steering, disconnect power steering line from reservoir on shift control pedestal and drain fluid into clean receptacle.

7. Disconnect transmission control shaft at rear joint, disconnect engine controls, and other transmission controls, then remove gearshift control pedestal assembly.

8. Disconnect and remove radiator upper and lower hoses and vent lines.

9. Unbolt and remove fan upper shroud from radiator.

10. Remove the front oil filler pipe and dipstick tube.

11. Disconnect and remove air inlet pipe used

between air cleaner and adapter on blower housing.

12. Disconnect exhaust pipes from exhaust manifolds.

13. Disconnect compressed air discharge line at compressor muffler.

14. At transmission, disconnect speedometer drive and transmission shift air lines (when used).

15. If a rear support is used at transmission, remove the support mounting.

16. Disconnect tachometer drive from engine. Also disconnect all engine wiring necessary for engine removal.

17. Disconnect propeller shaft at rear of transmission.

18. If vehicle is equipped with air conditioning, remove refrigerant compressor and disconnect lines as required.

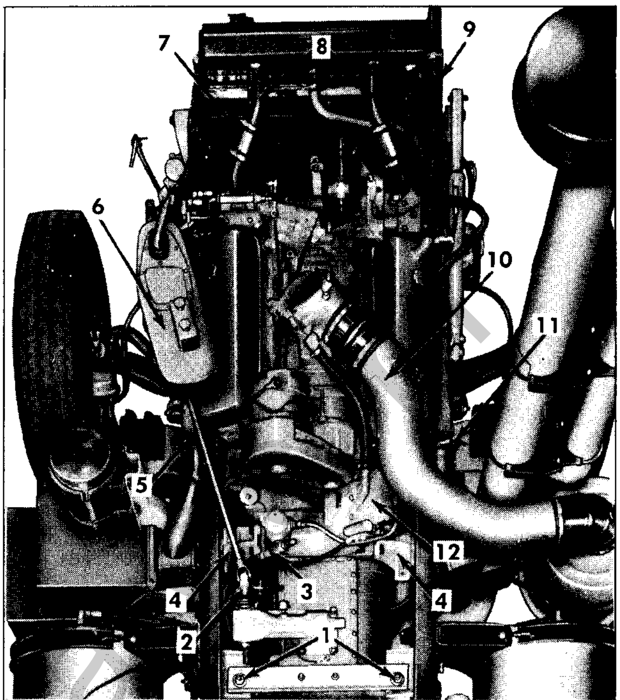
19. Remove power steering pump and tie to frame. The fluid lines may remain attached to the pump.

20. Attach overhead lifting equipment to power plant, then remove engine rear mounting caps.

21. At front of engine, remove front mounting bolts. In some instances it may be necessary to remove fan blades and front mounting bracket to prevent interference with radiator core.

22. Carefully raise the power plant assembly out of chassis and support on engine stand. Referring to appropriate section of this supplement for instructions required for removing engine trim items.

Transmission and clutch removal procedures are covered in TRANSMISSIONS AND CLUTCHES (SEC. 7) in this supplement.



1 Transmission Rear Support (When Used)
2 Transmission Control Shaft and Joint
3 Compressed Air Discharge Line
4 Engine Rear Mounting
5 L.H. Exhaust Connection
6 Control Pedestal
7 Fan Shroud
8 Radiator Upper Hose
9 Oil Filler and Dipstick
10 Air Inlet Pipe
11 R.H. Exhaust Connection
12 Air Compressor T-6068

Figure 19—V8-71 Diesel Engine Installed (Tilt Cab) (Typical)

V-TYPE ENGINE INSTALLATION (TILT CAB MODELS)

1. Install clutch, transmission, and engine trim items on engine referring to appropriate sections in this manual for necessary instructions. Figure 19 shows view of engine installation with typical accessories.

2. Install the power plant in chassis by reversing the removal procedures previously given. Refer to ENGINE MOUNTINGS (SEC. 6D) in this manual for bolt torque and other information regarding mounting parts.

3. After all equipment has been installed, fill cooling system, engine crankcase, and power steering reservoir (when used). Also check transmission lubricant level.

4. Start engine, make necessary adjustments and check for leaks.

IN-VEHICLE ENGINE COMPONENT REPLACEMENT

NOTE: On vehicles equipped with engine brake system. Refer to "Engine Brake" later in this section for removal of engine brake components.

ROCKER ARM COVER REPLACEMENT

On engines with an engine brake, the electrical wire connecting switch with the terminal under rocker arm cover must be disconnected to allow cover removal. If the wire is to be removed from cover, both ends of wire must first be disconnected so wire can turn with the threaded insulator as it is threaded out with wrench.

Use new rocker arm cover gasket when installing cover.

VALVE SPRING REPLACEMENT (CYLINDER HEAD INSTALLED)

It is possible, if occasion requires, to remove or replace the exhaust valve springs without removing cylinder head. The springs, however, are normally removed when the head is off the engine.

An exhaust valve spring may be removed, without removing cylinder head from the engine, as follows:

1. Remove valve rocker cover.
2. If engine brake equipment is used, disconnect wiring as necessary to lift brake unit out of position and to allow removal of valve bridge.
3. Turn engine crankshaft so valve and injector rocker arms are in line horizontally.

NOTE: If a wrench is used on crankshaft pulley bolt when turning crankshaft, turn only in clockwise direction to avoid loosening bolt.

4. Disconnect and remove fuel lines from injector and fuel connectors.

CAUTION: Place a clean shipping cap over each fuel line opening in injector to prevent dirt from entering injector.

5. Remove the two bolts holding rocker arm shaft brackets to cylinder head, then tip the rocker arms up and away from valve bridges.
6. Remove exhaust valve bridge from guide at valve spring which is to be replaced.
7. Turn crankshaft to place piston at top of its stroke.
8. Thread the spring compressor tool (J-7455) into one of the rocker arm shaft bracket bolt holes in cylinder head (fig. 20).
9. Compress the valve spring and remove two valve stem locks. Release tool and remove spring cap, valve spring, and spring seat.
10. Reassemble spring seat, spring, and spring cap, then use tool in same manner as described for removal to compress spring. Install two valve locking keys in groove in valve stem.
11. Adjust valve bridge as directed previously in this section under "Final Tune-up Operations."
12. Check exhaust valve clearance as directed previously in this section under "Final Tune-up Operations."
13. Install rocker arm cover using new gasket.

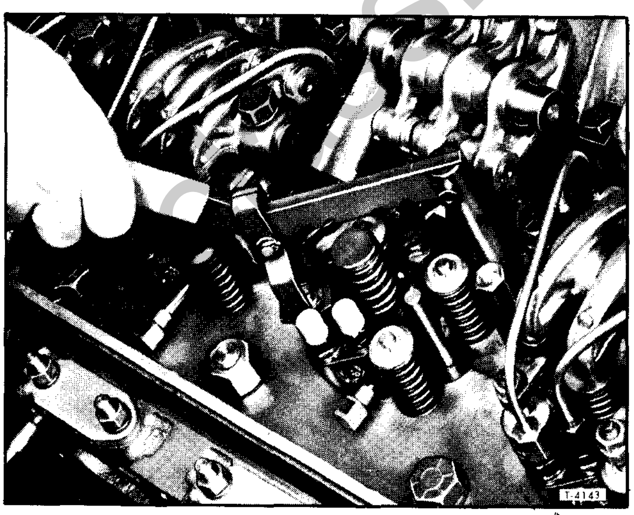


Figure 20—Use of Special Tool (J-7455) for Replacing Valve Spring with Cylinder Head Installed

VALVE PUSH ROD AND/OR SPRING REPLACEMENT

In case it becomes necessary to replace a push rod and/or push rod spring, the procedure given below may be used to accomplish the operation without removing cylinder head from engine.

1. Remove rocker arm cover.
2. Disconnect and remove the fuel lines from injector and fuel connectors. Cap the threaded openings in injector to keep out dirt.
3. Remove rocker arm shaft bracket bolts at group of rocker arms requiring service. Remove rocker arm shaft from rocker arms and brackets.

CAUTION: When removing the rocker arm shaft, tip back the three rocker arms just far enough to permit removal of shaft. Do not force the rocker arms all the way back with shaft in place as excessive load may bend push rods.

4. Loosen push rod lock nut and unscrew the clevis and rocker arm assembly from push rod. Remove lock nut from push rod.
5. Assemble special tool (J-3092-01), flat washer, and nut as shown in figure 21, at push rod to be removed. Tighten push rod nut against washer until tension on push rod spring retainer is relieved. Use screwdriver in manner shown (fig. 21) to pry retainer ring out of groove in cylinder head.

NOTE: To facilitate removal of retainer ring, the camshaft should be turned to position the cam follower on camshaft lobe base circle. This reduces spring pressure against push rod spring upper seat.

6. Remove push rod, spring, and spring upper and lower seats as an assembly. Remove nut, washer, and tool from push rod.
7. Assemble spring and spring seat on push rod and use tool (J-3092-01) with flat washer (fig. 21) and nut to compress push rod spring.
8. Insert push rod into cavity in cam follower (in cylinder head), then install retainer ring in groove in cylinder head.
9. Remove lock nut, washer and tool from push rod, then thread lock nut on push rod to end of threaded section.
10. Install rocker arm and clevis assembly on push rod.

CAUTION: Push rod must be initially threaded into rocker arm clevis until end of push rod is flush with, or protrudes beyond inner surface of clevis yoke. Failure to do this may result in damage caused by piston striking valve when engine is cranked. Final adjustment of valve lash is made as previously directed in this section under "Final Tune-up Operations."

11. Assemble rocker arm shaft and brackets and bolt brackets in place on cylinder head. Finished side of each bracket must be toward rocker arm. Tighten rocker arm shaft bracket bolts to 90 to 100 foot-pounds torque.

12. Assemble fuel lines, tightening line nuts to 12 to 15 foot-pounds using special wrench (J-8932-01).

13. Adjust exhaust valve lash and check injector timing. Refer to "Engine Tune-Up Operations" in this section for procedure.

CYLINDER HEAD REPLACEMENT (IN-LINE 6-71 N/NE ENGINES)

Equipment and cab style on different vehicles varies to such an extent that no attempt is made to enumerate every step required to remove cylinder head from engine with engine installed. However, the instructions following will serve as a guide to accomplish cylinder head replacement.

REMOVAL

1. Drain cooling system to level below cylinder head.
2. Disconnect battery.
3. Remove engine cover from inside cab on conventional cab models, or tilt cab and secure in tilted position on tilt cab models.
4. Disconnect and remove air intake hose and air cleaner(s) as required. Disconnect radiator hose from water outlet manifold.
5. On tilt cab models, remove control island and brackets.
6. Disconnect exhaust pipe from manifold.
7. Remove rocker arm cover and remove cover from governor housing.
8. Disconnect fuel control rod from injector rack tube and from governor lever, then remove rod.
9. Remove bolts attaching governor housing to cylinder head, and remove bolts attaching governor drive housing to blower housing. Remove governor housing from engine.
10. Remove exhaust manifold and water outlet manifold from cylinder head.

NOTE: If head is to be reinstalled and there is sufficient clearance, the manifolds may be left on the cylinder head.

11. Disconnect fuel supply line and return line.

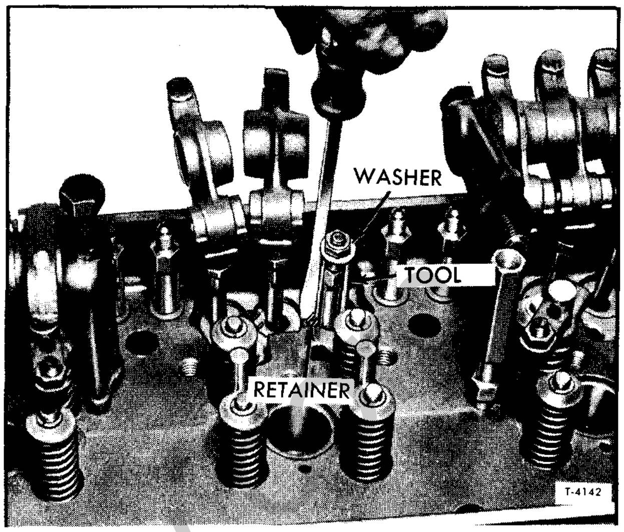


Figure 21—Tool Application for Replacing Push Rod

12. Remove injector rack control tube and brackets. Also remove fuel lines from injectors and fuel connectors.

CAUTION: Cover each fuel fitting opening with shipping cover as soon as fuel lines are removed. Dirt must not be permitted to enter the fuel system.

13. If control brackets or other equipment is mounted on cylinder head, remove bracket attaching bolts.
14. Loosen the two bolts directly below lifting bracket at each end of engine which attach balance weight cover and flywheel housing to end plates. If this is not done the ends of bolts may be in contact with cylinder head surfaces and interfere with removal of head.
15. Remove two bolts attaching front lifting bracket to balance weight cover, and the two bolts holding rear lifting bracket to flywheel housing.
16. Loosen rocker arm shaft bracket bolts to relieve tension on exhaust valve springs, then remove cylinder head stud nuts and bolts.
17. Lift cylinder head off the studs, then remove from engine.

CAUTION: Do not set cylinder head on bench with bottom face down, as cam follower rollers and injector spray tips may be damaged.

Cylinder head holding plates (J-3087-01) should be attached to cylinder head to hold the head above bench and facilitate service operations.

18. Remove cylinder head compression gaskets, oil seals, and water seals from block. Clean the cylinder head surface which mates with cylinder block.

NOTE: If new cylinder head and/or components are to be installed, refer to applicable overhaul manual for necessary instructions to transfer parts, and make inspections and repairs to cylinder head.

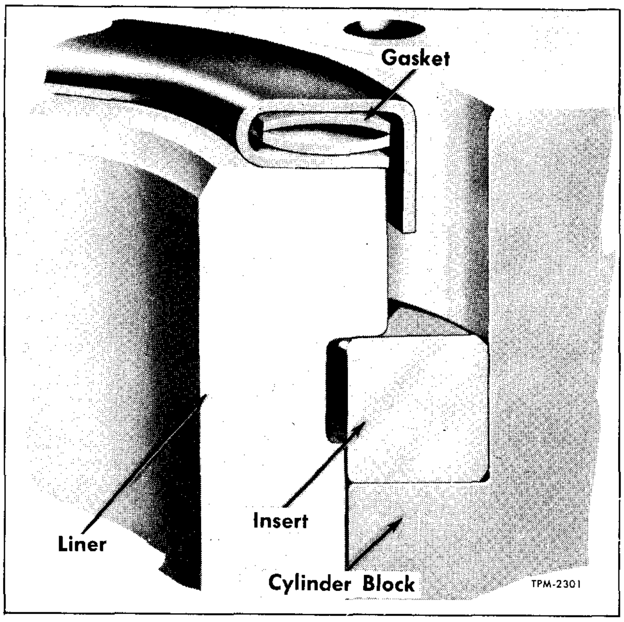


Figure 22—Compression Gasket at Cylinder Liner

CYLINDER HEAD INSTALLATION

1. Inspect top of pistons to see that they are clean and free from carbon deposits. Also check and, if necessary, remove any deposits found in groove and counterbores in top of cylinder block. Also inspect cylinder head studs for damaged threads.

2. Install new cylinder head compression gaskets and seals as follows:

a. Install a new compression gasket on each cylinder liner (fig. 22).

b. Place new seal rings in the counterbores of water and oil holes in cylinder block.

c. Install a new oil seal in milled groove near the outer edge of area covered by cylinder head - do not stretch the seal.

NOTE: Used water seals, oil seals, and compression gaskets should never be re-used.

3. Just before installing cylinder head on engine make final visual check to be sure all gaskets and seals are in place at cylinder block and properly located.

CAUTION: Compression gaskets and/or seals which are jarred out of their proper location will allow leaks and "blow-by" which will result in poor performance and damage to engine.

4. Wipe bottom of cylinder head clean, then lower cylinder head onto studs and down into contact with block. Lubricate stud threads and contact area on stud nuts with International Compound #2 or equivalent, then install stud nuts. Before tightening stud nuts, be sure the rocker arm shaft bracket bolts are loosened so the cylinder head can seat squarely on seals and gaskets when tightening cylinder head stud nuts.

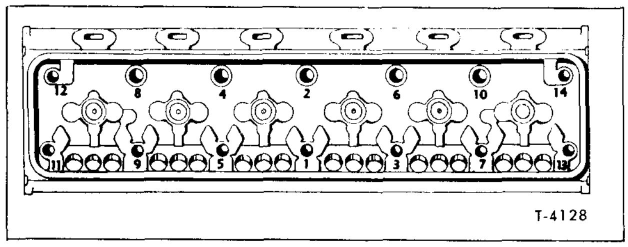


Figure 23—Cylinder Head Bolt Tightening Sequence on In-Line Engine (6-71 N/NE)

5. Tighten bolts and stud nuts lightly on camshaft side of head first to compress the cam follower springs. After head is squarely seated, use a torque wrench to tighten nuts and bolts in sequence shown in figure 23. Tighten each nut and bolt about one-half turn at a time until all are firmly tightened, then finally tighten all bolts and nuts to 175 to 185 foot-pounds. Do not exceed the high limit, as this may stretch the parts beyond their elastic limit.

6. Tighten the cover bolts (loosened when removing head) directly below the lifting bracket locations at each end of engine.

7. Using new gaskets, install lifting brackets and tighten bolts in sequence indicated in figure 24. Final torque for lifting bracket bolts is 55 to 65 foot-pounds.

8. Tighten rocker arm shaft bracket bolts to 90 to 100 foot-pounds with torque wrench. Install injector rack control tube and lever assembly and tighten bracket bolts to 10 to 12 foot-pounds. Install fuel lines at injectors and fuel connector fittings. Use special wrench (J-8932-01) and tighten fuel line nuts to 12 to 15 foot-pounds torque.

9. Install exhaust manifold and connect exhaust pipe. Connect air intake hose.

10. Use new gaskets and install governor housing assembly at blower housing and side of cylinder head.

11. Install governor control rod between lever in governor housing and lever on injector control rack. Install cover on governor housing.

12. On tilt cab models install control island. Connect engine controls, and any electrical wiring.

13. Install water manifold (if removed) and connect radiator hose. Fill cooling system. Connect battery cables.

14. Perform tune-up procedure to assure correct valve lash, injector timing, and other operations involving items which were disturbed in replacing cylinder head.

NOTE: After engine has been started and operated long enough to reach normal operating temperature (160°-185°F.), the cylinder head should be retorqued; and valve clearance and injector timing rechecked.

15. Install cover on cylinder head using new gasket. Check to see that all clips, brackets, and lines removed from cylinder head have been reinstalled.

CYLINDER HEAD REPLACEMENT (V-TYPE DIESEL ENGINE)

Equipment and cab style on different vehicles with V-type Diesel engines varies to such an extent that no attempt is made to enumerate every step required to replace cylinder head with engine installed. However, the instructions following will serve as a guide to accomplish cylinder head replacement. Unless otherwise specified, the instructions apply to the cylinder head at either right-hand or left-hand bank of cylinders on 8V-71 Series engines.

REMOVAL

1. Drain cooling system to level below cylinder heads.
2. Disconnect battery.
3. Tilt cab forward on such models and secure cab in tilted position. On conventional cab models, the fenders and hood assembly can remain on vehicles, or if desired the assembly may be removed. Removal of hood and fenders will provide better access for use of crane-type floor hoist to lift off and install cylinder head.
4. On tilt cab model vehicles, remove the control island. Carefully observe arrangement of wiring, controls, and brackets so they can be reassembled in original position. Disconnect exhaust pipe from manifold and remove manifold from engine.
5. Disconnect fuel supply and return lines from cylinder head.
6. Loosen hose clamps and remove hose from thermostat housing cover. Loosen hose clamps on water by-pass tube and remove tube.
7. Remove cylinder head rocker arm cover and governor housing cover. Disconnect and remove fuel rod between governor lever and lever on injector rack control tube.
8. Loosen fuel rod cover hose clamps, then move hose toward governor.
9. Remove injector control tube and brackets as an assembly.
10. Remove the fuel lines from injectors and fuel connectors. Immediately cap the fittings on injectors and fuel connectors to prevent entrance of dirt.
11. Loosen rocker arm bracket bolts to relieve valve spring pressure and cam follower.
12. Remove bolts attaching thermostat housing to front of cylinder head.
13. Remove cylinder head bolts, and stud nuts, then attach lifting equipment, and remove cylinder head. If interference is encountered when removing right bank cylinder head, loosen any of the flywheel housing attaching bolts which may be causing the interference.

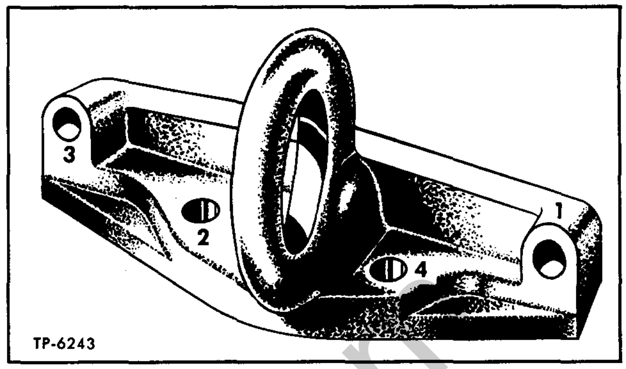


Figure 24—Lifting Bracket Bolt Tightening Sequence

NOTE: Cam follower rollers and injector spray tips may be damaged if cylinder head is allowed to rest on these parts. Wooden blocks should be placed on bench to support head at each end and prevent damage to injectors and cam followers. Holding plates (J-3087-01) can be used to support head while cleaning.

14. Remove cylinder head compression gaskets (fig. 22), oil seals, and water seals from block. Clean the cylinder head surface which mates with cylinder block.

NOTE: If new cylinder head and/or components are to be installed, refer to applicable overhaul manual for necessary instructions to transfer parts, and make inspections and repairs to cylinder head.

CYLINDER HEAD INSTALLATION

1. Inspect top of pistons to see that they are clean and free from carbon deposits. Also, check and, if necessary, remove any deposits found in groove and counterbores in top of cylinder block.

2. Install new cylinder head compression gaskets and seals as follows:

a. Install a new compression gasket on each cylinder liner (fig. 22).

b. Place new seal rings in the counterbores of water and oil holes in cylinder block.

c. Install a new oil seal in milled groove near the outer edge of area covered by cylinder head - do not stretch the seal.

NOTE: Used water seals, oil seals, and compression gaskets should never be re-used.

3. Just before installing cylinder head on engine make final visual check to be sure all gaskets and seals are in place at cylinder block. Apply International Compound #2 or equivalent on cylinder head bolt threads and bolt head contact area.

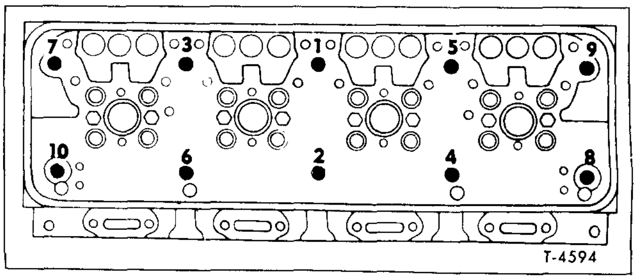


Figure 25—Cylinder Head Bolt Tightening Sequence

CAUTION: Compression gaskets and/or seals which are jarred out of their proper location will allow leaks and "blow-by" which will result in poor performance and damage to engine.

4. Wipe bottom of cylinder head clean, then lower cylinder head onto studs and down into contact with block.

5. Start cylinder head bolts into block, and install stud nuts; then beginning with bolts on camshaft side of head, tighten head bolts lightly to compress cam follower springs and seat cylinder head.

6. Tighten cylinder head bolts and stud nuts about one-half turn in sequence shown in figure 25. Use torque wrench for final tightening of cylinder head bolts and nuts. Correct torque is 190 to 200 foot-pounds. Do not tighten beyond the specified torque.

7. Cover oil drain holes in head to prevent foreign objects from falling into holes. Install injectors (if removed) referring to applicable portion of ENGINE FUEL SYSTEM (SEC. 6M) of this manual, for instructions. Check push rods to see that each one is threaded completely through clevis, before attempting to crank the engine. Damage to valves or push rods may occur if push rods are not screwed far enough into clevises.

8. Tighten rocker arm shaft bracket bolts to 90 to 100 foot-pounds with torque wrench.

9. Install injector rack control tube and bracket assembly. Torque the tube bracket bolts to 10 to 12 foot-pounds. Check operation of injector rack control tube. Tube must be free in bearings and spring must return the injector racks to "No-Fuel" position after it is moved to "Full-Fuel" position. If there is binding of tube in bearings, strike the control tube brackets lightly with hammer to correct any misalignment of tube bearings.

10. Install fuel lines at injectors and at fuel connectors. Fuel line nuts must be tightened to 12 to 15 foot-pounds torque with special tool (J-8932-01).

11. Install and connect fuel rod between rack control tube lever and governor lever, then install governor housing cover. Be sure fuel rod cover (hose) is moved into place and clamped in position.

12. Bolt thermostat housing to front of cylinder head using new gasket. Connect all radiator hoses and by-pass tube hoses.

13. Install exhaust manifold and connect exhaust pipe.

14. Perform initial tune-up operations to assure correct valve clearance and injector timing, and other operations involving items which were disturbed in replacing cylinder head. Tune-up procedures are covered previously in this section under "Engine Tune-up Operations."

NOTE: Cylinder head bolt torque must be rechecked and "Final Tune-up Operations" must be performed after engine has been started and warmed up to normal operating temperature.

15. Install rocker arm cover using new gasket.

16. Reverse the procedures given under steps 1 through 5 under "Removal" to finish the cylinder head installation procedures.

17. Warm up engine and check for oil and water leaks. Perform final tune-up operations.

ENGINE OIL PAN REPLACEMENT

NOTE: Oil pan on most vehicles is equipped with a removable sump attached to bottom of oil pan directly below the oil pump inlet screen. If it is only necessary to clean oil pan and/or screen, remove sump from oil pan. Use new gasket when installing sump and tighten bolts evenly.

Accomplish oil pan replacement as follows:

1. Remove the drain plug and drain the engine lubricating oil.

2. Detach the oil pan; take precautions to avoid damaging the oil pump inlet pipe and screen. If desired, the inlet pipe assembly and gasket can be readily replaced.

3. Remove the oil pan gasket completely, then clean flange surfaces.

4. Clean the oil pan with a suitable solvent; dry the oil pan.

5. Inspect the oil pan for large dents or breaks in the metal which may necessitate its repair or replacement. Check for misaligned flanges or raised surfaces surrounding bolt holes by placing the pan on a surface plate or other large flat surface.

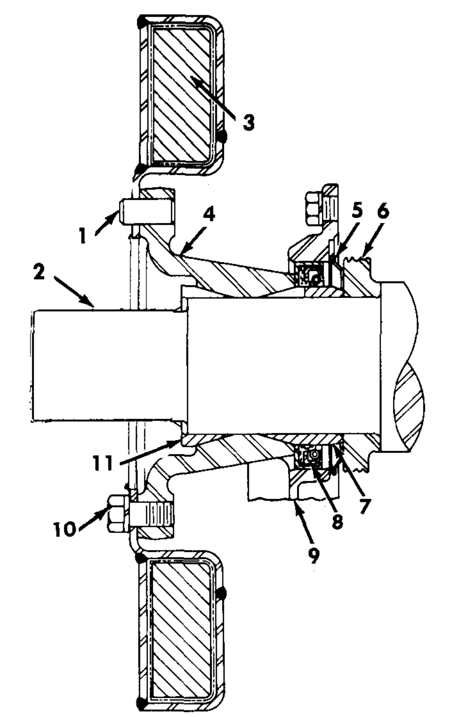
6. When replacing the pan, use a new gasket and tighten the bolts evenly to avoid damaging the gasket or springing the pan.

7. Install the oil drain plug. Replenish crankcase lubricating oil.

VIBRATION DAMPER, FRONT COVER, AND OIL SEAL

DAMPER REPLACEMENT

A vibration damper assembly (fig. 26) is installed at hub on front of crankshaft on 6-71 engines. The damper assembly is secured by bolts



1 Dowel
2 Crankshaft
3 Vibration Damper
4 Vibration Damper Hub
5 Oil Slinger
6 Oil Pump Drive Gear
7 Tapered Cone - Inner
8 Oil Seal
9 Crankshaft Front Cover
10 Cap Screw
11 Tapered Cone - Outer

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Figure 26—Vibration Damper Typical Installation

and located on hub by dowel pins. When fan is mounted on end of crankshaft remove fan and hub to allow damper removal. Figure 27 shows use of tool for removing damper hub.

CAUTION: DO NOT hammer or pry on damper shell as this will cause irreparable damage to unit.

FRONT COVER REPLACEMENT

On V-type engines the engine oil pump parts are assembled into a cavity in crankshaft front cover. Reference should be made to applicable overhaul manual for instructions covering replacement of front cover and oil seal, as well as the oil pump components.

Crankshaft front cover and oil seal on 6-71 engines can be replaced by following instructions given below;

FRONT COVER AND OIL SEAL REMOVAL (6-71 ENGINES ONLY)

1. Drain crankcase and remove oil pan and gasket.

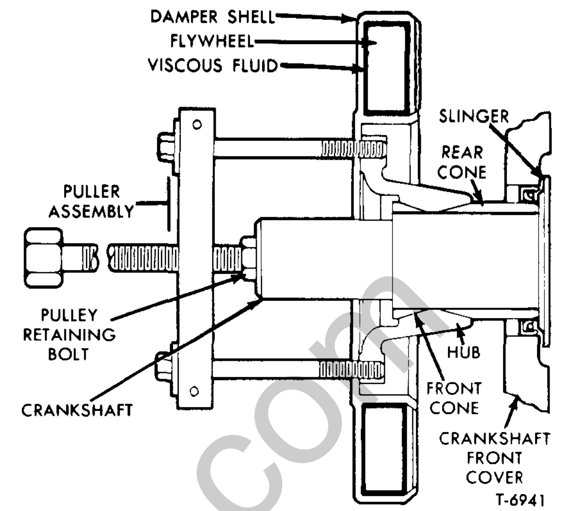


Figure 27—Use of Puller to Remove Damper Hub From Crankshaft

2. Remove bolt and retainer which hold pulley and hub on crankshaft.

3. Use puller to remove pulley and/or hub from crankshaft. Remove pulley keys from crankshaft.

4. Remove vibration damper and hub using tool (J-4794-01) as shown in figure 27. Install pulley retaining bolt in threaded hole in crankshaft to provide a bearing point for puller screw as shown. Front cone will be removed with damper hub.

CAUTION: Do not use hammer or pry bars to attempt viscous type damper removal, as the damper shell may be dented. If shell is dented the damper assembly will become ineffective and will require replacement since it cannot be repaired.

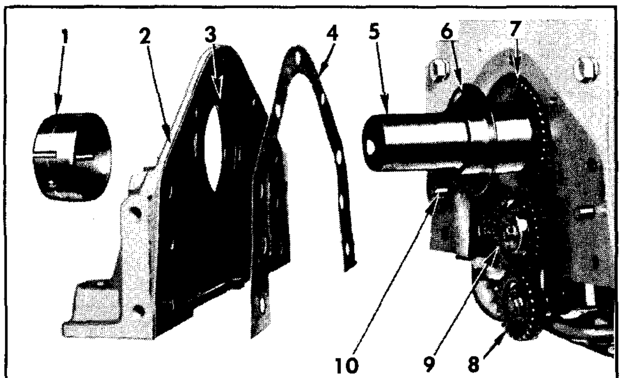
5. Remove bolts which mount the cover to engine, then tap alternately with hammer at each side of cover to start the cover off dowel pins. Move cover straight away from engine until clear of crankshaft. Remove rear cone (1, fig. 28) from crankshaft. Remove cover gasket.

6. Inspect damper rear cone which provides seat for oil seal. If cone is grooved or otherwise damaged, install new cone. Inspect oil slinger at oil pump drive gear on crankshaft. Slinger must be in good condition.

7. Inspect oil seal. If lip is worn a new seal must be installed. Use arbor press to remove old seal and press new seal squarely into cover with seal lip pointing toward inner side of cover.

FRONT COVER AND OIL SEAL INSTALLATION (Refer to Figs. 28 and 29)

1. Check gasket area on engine and on front cover. Scrape off any sealer or gasket portions which may be found.



1 Vibration Damper Cone
2 Front Cover
3 Oil Seal
4 Gasket
5 Crankshaft
6 Oil Slinger
7 Pump Drive Gear
8 Pump Driven Gear
9 Pump Idler Gear
10 Dowel

TPM-2528

Figure 28—Crankshaft Front Cover Mounting

2. Place new gasket at bolting flange of crankshaft front cover and attach to engine with washers and bolts. Do not fully tighten bolts until all bolts have been started and threaded in until bolt heads contact washers, and the damper hub rear cone has been installed. (See step 3. below:)

3. Apply engine oil on oil seal lip and on damper hub rear cone, then install cone with tapered end of cone pointing toward front end of crankshaft (fig. 29).

4. Following sequence shown in figure 29, tighten 3/8-24 bolts to 25 to 30 foot-pounds torque, and 1/2-13 bolts to 80 to 90 foot-pounds.

5. Install engine oil pan with new gasket.

6. Install damper hub front cone, then install crankshaft pulley keys, pulley, retainer washer, and bolt. Tighten bolt to 290 to 310 foot-pounds torque with torque wrench.

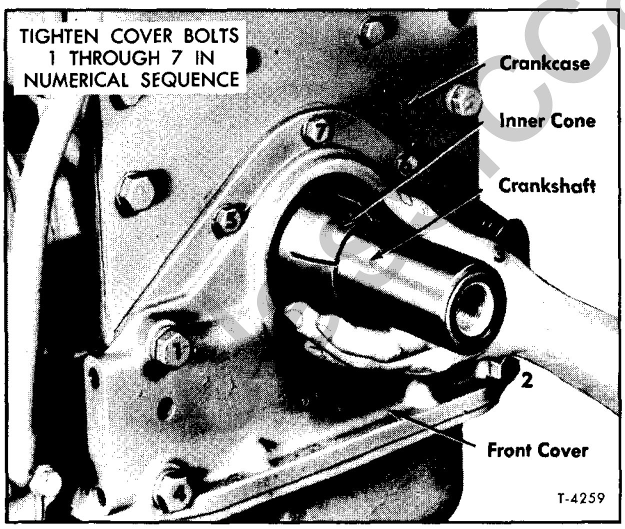


Figure 29—Front Cover and Damper Cone Installation and Bolt Tightening Sequence

CRANKSHAFT FRONT OIL SEAL REPLACEMENT (WITHOUT REMOVING FRONT COVER)

The method described below may be used in some instances to replace a crankshaft front oil seal without removing front cover from engine:

REMOVAL

1. Remove fan (if crankshaft mounted), pulley and damper (on In-line engines). Refer to procedure previously given under "Vibration Damper, Front Cover and Oil Seal" and follow applicable instructions to remove crankshaft pulley and damper hub.

2. Using a small bit, drill two diametrically opposite holes in the oil seal casing.

3. Thread two sheet metal screws with a flat washer on each one into holes in seal, then using two small pry bars under the washers, force the seal assembly outward from front cover.

IMPORTANT: Be careful not to damage the bore in cover.

INSTALLATION

1. Carefully clean any old sealant from bore in front cover.

2. Apply thin coat of sealant to outer diameter of new seal assembly. Also, apply a coat of clean grease to lip of oil seal.

3. With the lip of seal pointed toward engine, start seal assembly into bore of front cover. Using a hollow tube as a driving tool against outer diameter of seal, tap the seal assembly evenly until flush with the outer face of front cover.

4. On In-line engines install vibration damper on crankshaft, following instructions previously given under "Vibration Damper, Front Cover and Oil Seal." Start the pulley straight and true on crankshaft.

5. Assemble pulley retaining parts and fan assembly (when used). Correct torque for pulley retaining bolt is 290 to 310 foot-pounds.

Follow recommended procedures covering testing, inspection, and adjustments for best results.

ENGINE SENDING UNITS AND SWITCHES

OIL PRESSURE GAUGE SENDING UNIT

GENERAL

An electric oil pressure gauge system is used to show oil pressure at instrument panel. The pressure sending unit is installed in oil manifold threaded into oil gallery boss at right side of engine cylinder block below exhaust manifold on 8V-71 engine.

On 6-71 engine, the sending unit is at left side of cylinder block just ahead of flywheel housing.

The oil pressure gauge circuit is operative only when engine control switch is turned on.

TEST

In case electric oil gauge system fails to function, or if it gives an apparent false reading, system may be checked as follows:

1. Connect test lamp of not more than 2 C.P. between battery cable terminal on starter solenoid and the body of sending unit. If lamp fails to light, the unit is not grounded, and the threaded hole and the threads on the unit should be checked for metal-to-metal contact. If the lamp lights the unit can be considered grounded. (DO NOT USE A LAMP OF OVER 2 C.P.) When replacing sending unit do not use compound on threads.

2. Remove the wire from the unit terminal and connect the test lamp between the unit terminal and the battery cable terminal on the starter solenoid. If the lamp lights, start engine and observe if the lamp changes intensity. A satisfactory unit will change the lamp intensity at different engine speeds (changes in oil pressure).

3. Connect the wire and check wiring for open circuit between unit and gauge on instrument panel. A wiring diagram is attached to back side of instrument panel access cover.

4. If no defective wiring or connections exist, install new gauge.

NOTE: No attempt should be made to repair either the gauge or the sending unit.

LOW OIL PRESSURE SWITCH

OPERATION

The low oil pressure switch is installed on oil manifold adjacent to oil pressure gauge sending unit. On 8V-71 engine the oil manifold is at right side of engine toward rear, while on 6-71 In-line engine it is on left side of engine.

When there is no oil pressure or if pressure is less than three pounds, the switch points are closed. If circuit is energized by turning on the engine control switch, the "Low Oil" tell-tale light illuminates and warning buzzer sounds.

Whenever oil pressure increases sufficiently (approx. 4 psi) the diaphragm in switch causes points to open and tell-tale light goes out and buzzer stops.

CIRCUIT TEST

When engine control switch is turned on with engine stopped, the low oil tell-tale light should illuminate and buzzer should sound. If buzzer sounds but light does not come on, check for burned-out bulb and/or defective wiring. If tell-tale light illuminates but buzzer does not sound check the alarm buzzer and circuits.

ENGINE OIL TEMPERATURE SENDING UNIT

GENERAL

Some vehicles are equipped with an electrically-operated engine oil temperature gauge system. With this equipment, a threaded boss is provided in engine oil pan to accommodate the temperature sending unit. Unit is threaded into oil pan boss.

CIRCUIT TEST

1. Use a 12-volt, 2-candlepower bulb with test leads to check sending unit for proper ground connection. Clip one lead to sending unit body and other lead to 12-volt terminal. If test bulb lights, the unit is properly grounded. If bulb does not light, check for presence of sealing compound around threads of unit. Remove compound and repeat test. Make sure unit is properly grounded before proceeding with next test.

3. Remove test lead from body of unit, disconnect terminal wire, and connect lead to terminal of the unit. If bulb lights, engine unit is internally short-circuited and should be replaced.

4. Remove test light and connect wire to unit terminal.

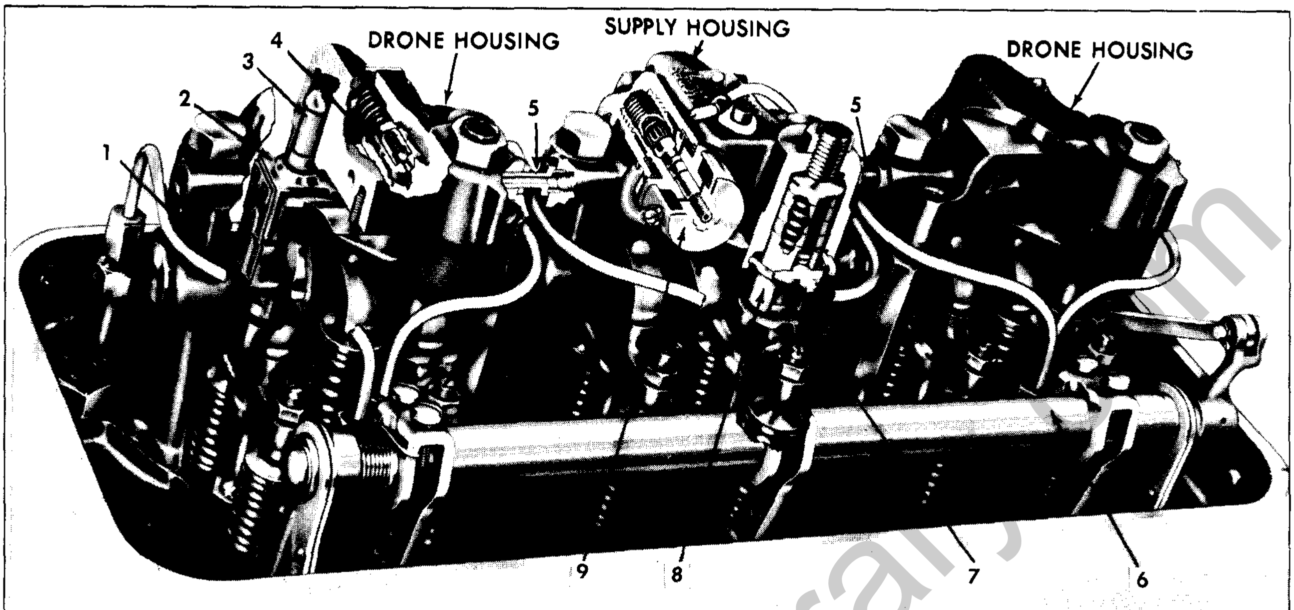
5. If engine sending unit tests satisfactorily under the above conditions, check following items according to nature of difficulty.

a. If gauge does not register when control switch is turned on there may be a break in the circuit between the gauge and the control switch or a short between this lead and ground.

b. If gauge shows abnormally high or low reading when engine temperature is known to be normal, refer to appropriate "Wiring Diagrams" booklet for wiring layout, and check for open or shorted circuit.

NOTE: Do not use compound on threads when installing unit in oil pan.

ENGINE BRAKE (OPTIONAL EQUIPMENT ITEM)



1 Injector Push Rod Clevis
2 Master Piston Fork
3 Master Piston
4 Control Valve
5 Oil Connector
6 Injector Control Tube
7 Exhaust Valve Bridge
8 Slave Piston
9 Solenoid Valve T-6100

Figure 30—Cut-Away View of Engine Brake Mechanism

DESCRIPTION AND OPERATION

The engine brake mechanism consists of a number of units so arranged as to increase the effectiveness of engine as a brake. Cut-away view (fig. 30) shows engine brake unit installation.

The increase in braking effectiveness is accomplished by transfer of injector push rod motion to a hydraulic master cylinder and piston which in turn operates a slave piston located above one exhaust valve bridge at each cylinder. As the injector push rod moves upward, engine oil admitted to oil circuits through 3-way solenoid valve, is trapped between master piston and slave piston so that slave piston is forced downward against valve bridge to open exhaust valves momentarily. This occurs as piston approaches upper-dead-center of stroke, thereby releasing the air compressed above piston. Without the engine brake mechanism, the air compressed on piston up stroke forces piston back down and tends to offset the braking which results when piston is forced upward. By releasing the compressed air from cylinder at top of piston stroke at all cylinders, a constant braking action takes place whenever foot is removed from accelerator. As accelerator is depressed, a switch breaks electrical circuit to oil supply solenoid valve and engine brake is no longer effective.

A manually-operated switch on instrument panel permits driver to turn engine brake on or off. Degree of braking when descending grades is controlled to a great extent by shifting transmission into a gear which will provide the required retardation. Refer to driving instructions in "Owner's and Driver's Manual" for specific information on use of engine brake.

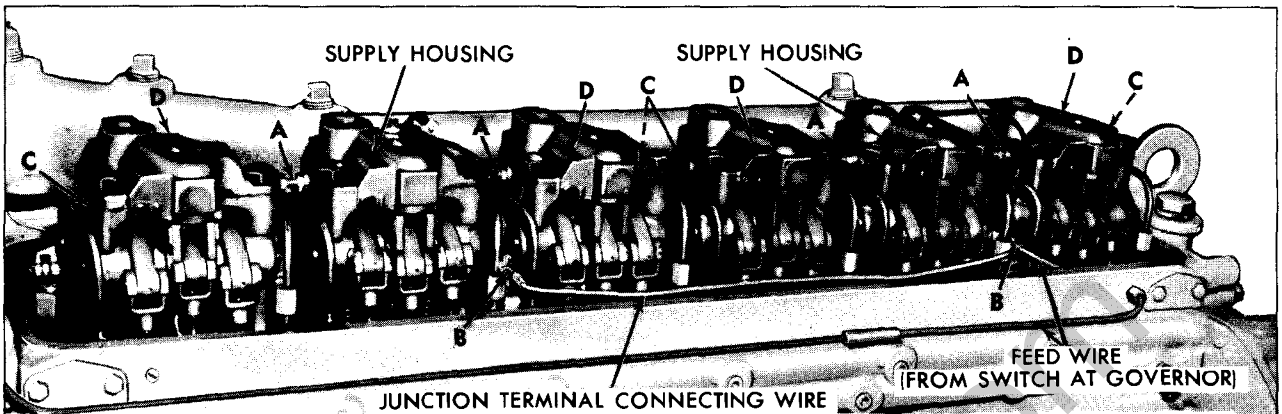
Figure 34 is a schematic arrangement of the electrical units used with engine brake. Refer to figure 33 for schematic layout of engine brake system components.

ENGINE BRAKE MAINTENANCE

No periodical maintenance operations are required at engine brake mechanism; however, an inspection should be made at scheduled engine maintenance intervals to determine condition of switches and wiring which are part of the system. Keep all electrical connections clean and tight.

Adjustments for valve bridge clearance and buffer screw micro-switch operation are included in the unit replacement procedures covered later in this section under "On-Vehicle Engine Brake Component Replacement."

Refer to "Engine Brake Trouble Diagnosis Chart" later in this section for possible causes



A - Oil Connector
B - Wire Junctions and Brackets
C - Threaded Oil Hole Plugs
D - Drone Housings

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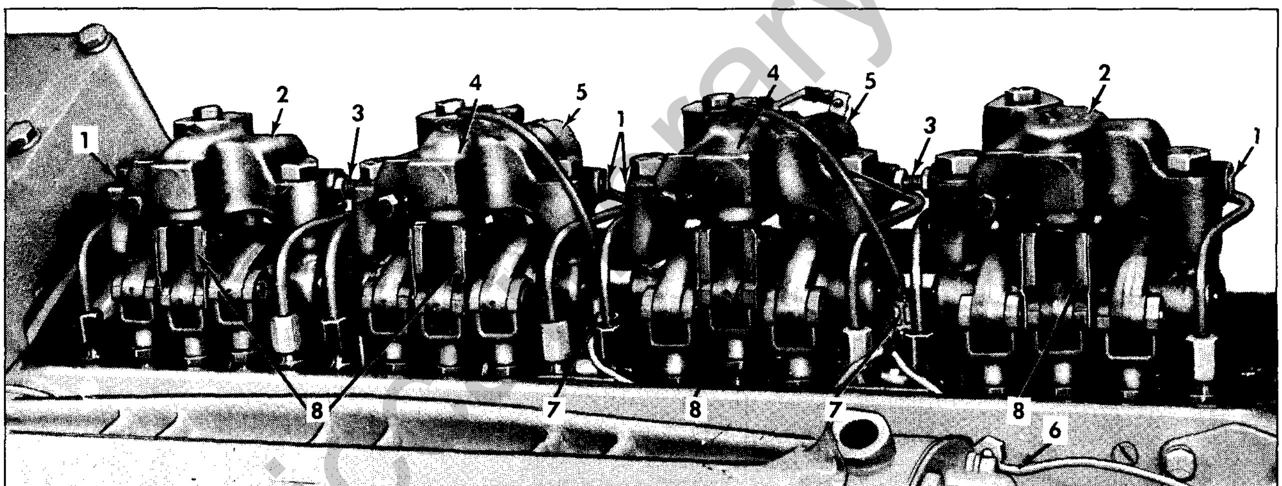
Figure 31—Engine Brake Mechanism on 6-71 Engine



1 Oil Passage Plug
2 Drone Housing Assembly
3 Oil Connector
4 Supply Housing Assembly
5 Solenoid Valve Assembly
6 Feed Wire
7 Wiring Junction
8 Master Piston Fork Assembly

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Figure 32—Engine Brake Mechanism on 8V-71 Engine

and remedies for various problems which could be traced to the engine brake system.

ON-VEHICLE ENGINE BRAKE COMPONENT REPLACEMENT

GENERAL

The engine brake system functions the same on In-line engines as on V-type engines; however, on In-line engines two supply housings are used and each one is connected to a pair of drone housings (fig. 31). Two supply housings and two drone housings are used at each bank of cylinders on 8V-71 engines (fig. 32). The same arrangement of housings is used at both cylinder banks. Refer to figure 33 for schematic arrangement of units and hydraulic circuits.

The same arrangement of electrical wiring, switches, and solenoid valves is used on 6-cylinder and 8-cylinder engines; i.e., the switches are connected in series and the solenoid valves are wired in parallel (fig. 34).

The following instructions cover procedures in logical sequence for removing and installing the engine brake system components from an In-line 6-cylinder engine or one bank of an 8V-71 engine. Unless otherwise indicated the instructions apply to either the 6-, or 8-cylinder engine.

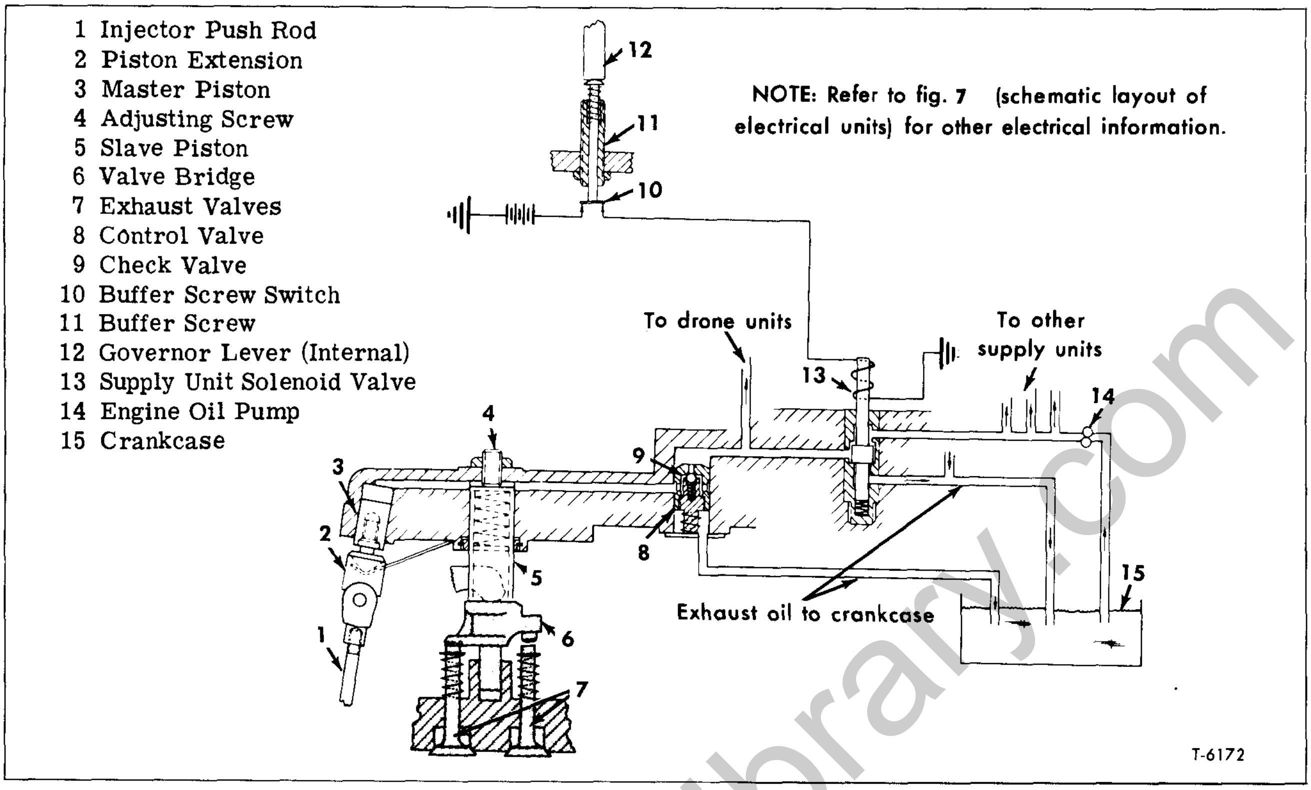


Figure 33—Schematic Arrangement of Brake Units and Hydraulic Circuits

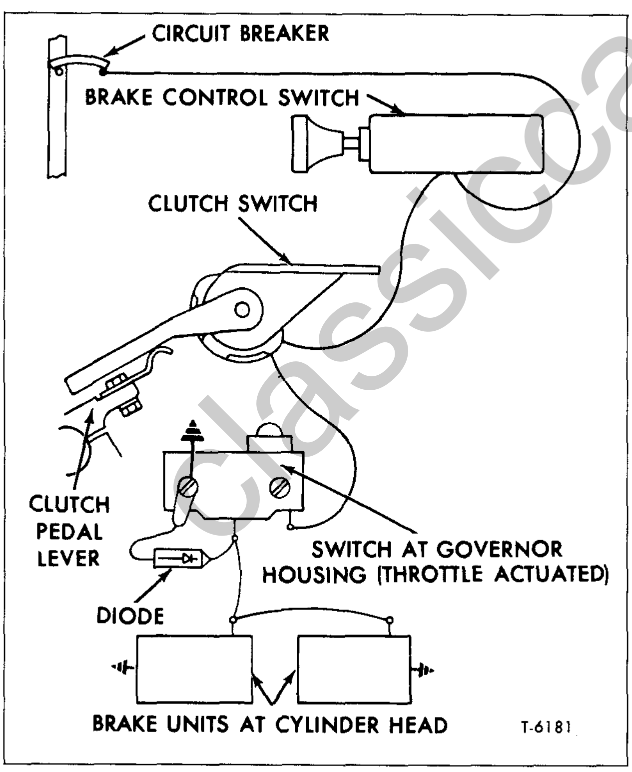


Figure 34—Schematic Arrangement of Engine Brake Electrical Wiring

ENGINE BRAKE COMPONENT REMOVAL

1. Remove valve rocker arm cover from cylinder head.
2. Disconnect solenoid wires from feed wire terminals.
3. Loosen lock nut on oil connector(s), then use wrench (fig. 35) to turn the connector into the drone unit far enough to permit removal of either housing.
4. Loosen and remove the supply and drone housing hold-down bolts, then lift off the housing assemblies. Remove the oil connector seal ring from the counterbore(s) in housing.
5. If necessary, to remove the wire terminal bracket, remove the bracket clamp bolt (fig. 37) and remove the bracket assembly from fuel tube risers. Disconnect all attached wires.
6. To remove feed wire, use wrench in manner shown in figure 37 to thread the insulator out of head. Both ends of wire must be free to allow wire to turn with insulator.

ENGINE BRAKE COMPONENT INSTALLATION

1. Check valve bridge adjustment as directed

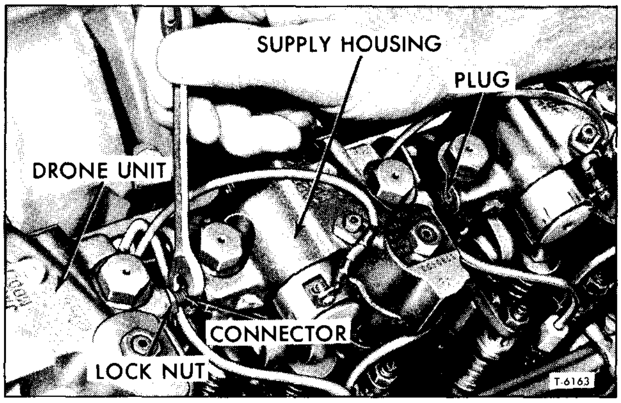


Figure 35—Removing or Installing Oil Connector

under "Engine Tune-Up Operations" earlier in this section.

NOTE: The valve bridge adjusting screw lock nut must not be loosened or tightened with bridge in place. Hold the bridge with vise to avoid bending bridge guide or valve stem.

2. If wiring terminal bracket was removed, locate bracket assembly at fuel tube risers and tighten clamp bolt with end wrench. Install feed wire and insulator in threaded hole in cylinder head flange, then connect feed wire at terminal on bracket (fig. 37).

3. If necessary to install fuel tubes, the standard tubes cannot be used with engine brake mechanism. The longer, curved tubes (fig. 5) must be used to provide space for the engine brake housings. When installing fuel tubes tighten tube nuts with torque wrench and adapter to 12 to 15 foot-pounds.

4. Lay out the engine brake housing assemblies and attaching parts in positions shown in figure 31 for 6-71 In-line engine or figure 32 for 8V-71 engine.

5. Install oil connector screw and lock nut (fig. 36) in drone housing assembly. Screw must be installed far enough to avoid interference with supply housing seal when assembling parts on engine.

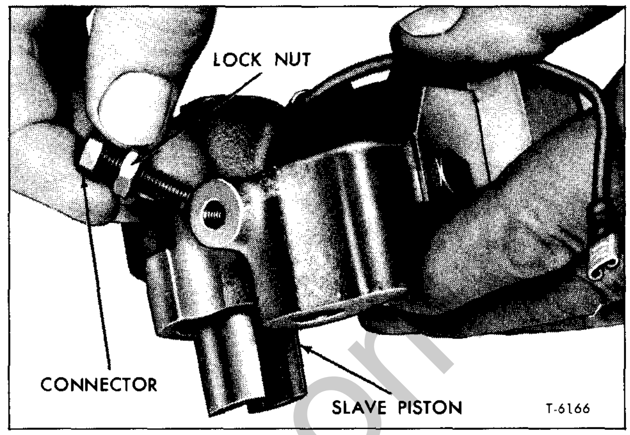


Figure 36—Installing Oil Connector in Housing (Prior to Housing Installation)

NOTE: Unused threaded opening in drone housings must be closed with special self-locking threaded plug.

6. Place oil connector seal ring in counterbore oil hole in oil supply housing(s) (fig. 38).

7. Place hold-down bolts through the engine brake housings, then set the housings in place over rocker arm shafts. The master piston fork and guide assemblies must fit over the injector push rod clevises.

8. Tighten the hold-down bolts alternately in gradual stages to seat parts solidly at cylinder head, then tighten bolts (fig. 39) to 90 foot-pounds with torque wrench.

9. Observe oil connector seal ring (fig. 38) and if necessary use narrow screwdriver to seat the seal squarely in counterbore in housing and

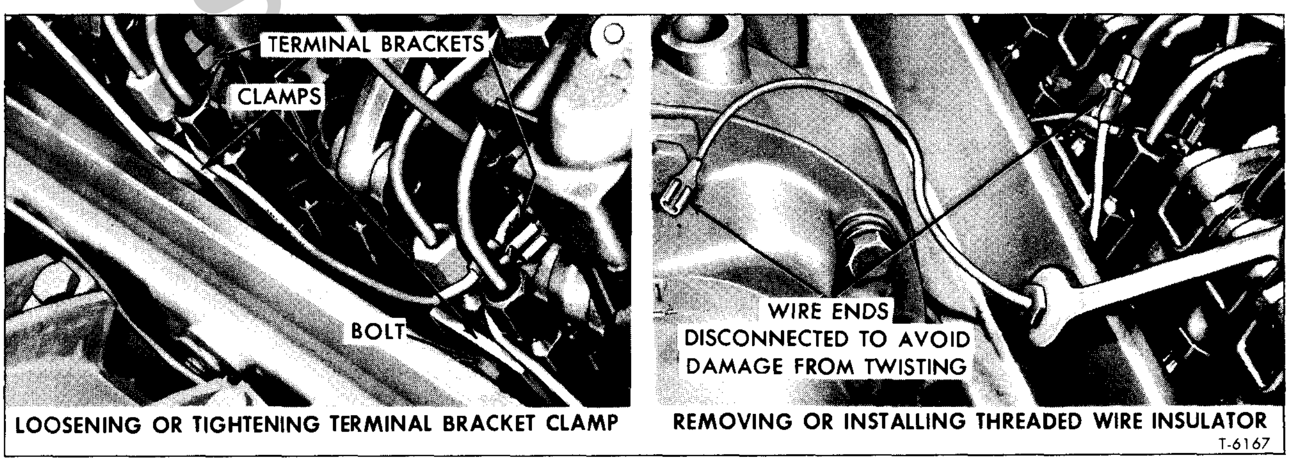


Figure 37—Engine Brake Unit Wiring Replacement

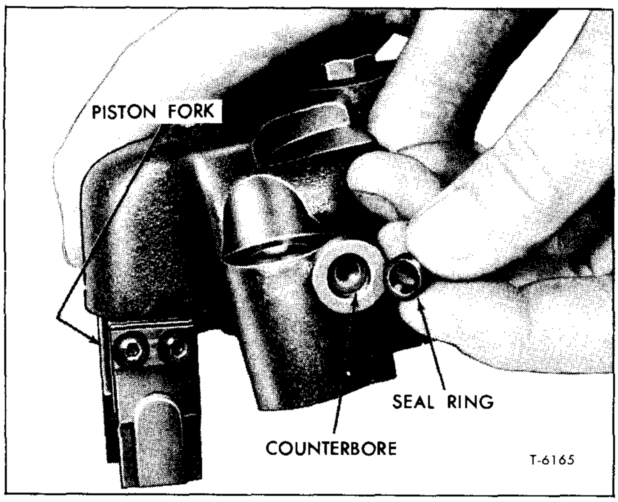


Figure 38—Oil Connector Seal Ring

recess in oil connector screw head. Back out the oil connector screw with wrench until screw head makes metal-to-metal contact with adjacent housing From this position back off the oil connector screw 1/3-turn to provide working clearance, then hold screw and tighten lock nut.

10. Refer to "Engine Tune-Up Operations" earlier in this section to adjust valve bridge clearance at each valve rocker arm.

11. Check injector timing at each injector using timing gauge. Refer to "Engine Tune-Up Operations" earlier in this section for necessary information.

12. Connect supply housing solenoid valve wires to terminals on terminal bracket (fig. 37).

13. Turn engine crankshaft to point where exhaust valves are closed and injector is in fuel-delivery position. Loosen lock nut on slave piston adjusting screw, then with wrench and special feeler gauge (fig. 40) adjust slave piston-to-valve bridge clearance to 0.066 inch and tighten lock nut. Recheck clearance at both feet of slave piston. If clearance differs between the two piston feet, adjust clearance under foot having least space. Hold

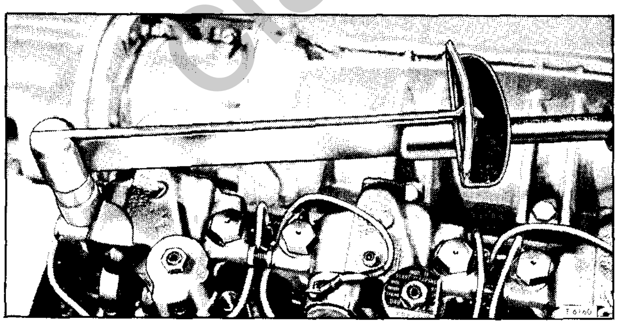


Figure 39—Torquing Housing Hold-Down Bolts (8V-71 Engine Shown)

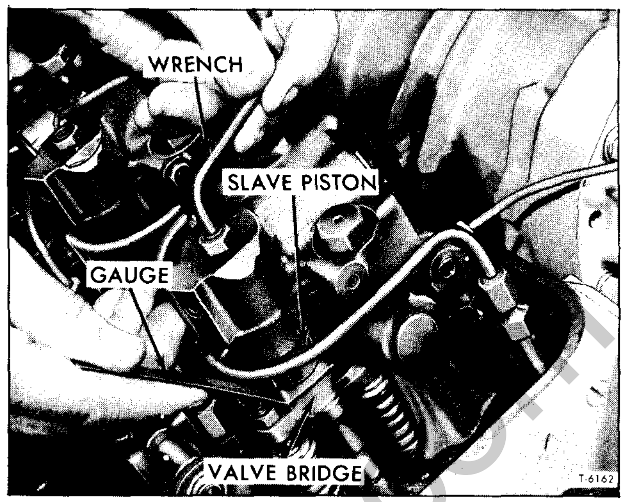


Figure 40—Adjusting Slave Piston Clearance

screw and tighten lock nut.

NOTE: The foregoing adjustment must be made at each slave piston.

14. Turn on engine control switch and engine brake switch at instrument console. Check for continuity of electrical circuit to the solenoid terminals. Make corrections as necessary to assure operation of all electrical units.

15. Install rocker arm cover(s).

ENGINE BRAKE SWITCH REPLACEMENT AND ADJUSTMENT

GENERAL INFORMATION

Three switches connected in series as illustrated in figure 34, are used to operate the engine brake system. The manually operated switch on control panel must be turned on in order for engine brake to function. Also there must be a closed circuit through switch at clutch lever (fig. 41) and micro switch at buffer screw (fig. 45) to supply current to solenoid valves at brake supply housings.

CLUTCH LEVER SWITCH REMOVAL

NOTE: Key numbers in text refer to figure 41.

1. Tilt the cab, and remove splash panel to expose clutch lever and switch.

2. Disconnect wires (6) from terminals on switch (3).

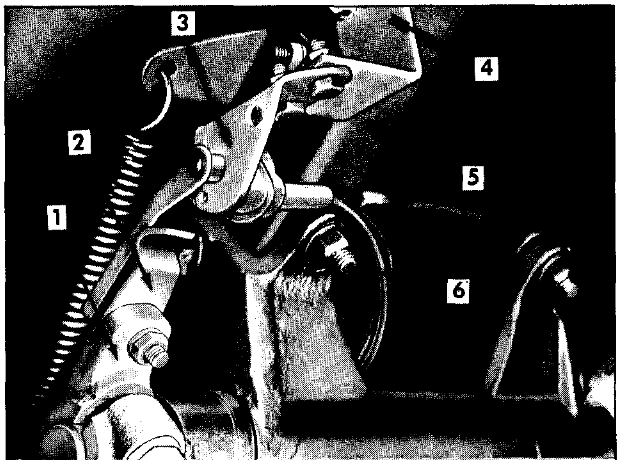
3. Remove bolts attaching switch (3) to bracket (4), and remove switch.

CLUTCH LEVER SWITCH INSTALLATION

NOTE: Key numbers in text refer to figure 41.

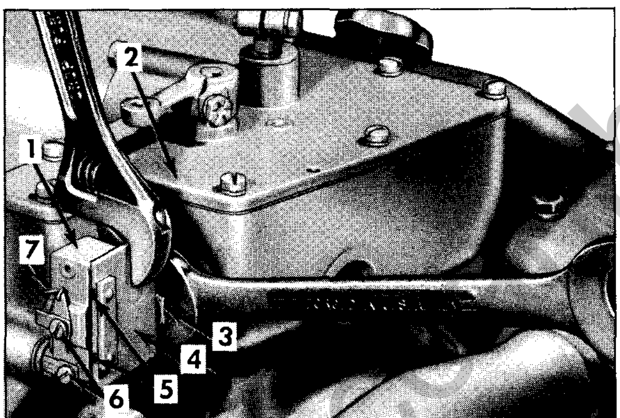
1. Position clutch lever switch (3) at lower side of bracket (4), then install bolts to attach switch to bracket.

2. Connect switch wires to terminals.



1 Clutch Pedal Lever
2 Switch Actuating Lever
3 Engine Brake Switch
4 Switch Bracket
5 Cab Sub-Frame
6 Switch Wires T-6197

Figure 41—Clutch Switch Installation



1 Switch
2 Governor Housing
3 Bracket Attaching Nut
4 Switch Bracket
5 Switch Adjustment Slots
6 Wire Terminals
7 Diode T-6161

Figure 42—Loosening or Tightening Switch Bracket Mounting Nut

3. Check lever extension (2) which must be in place and securely attached to clutch lever in position shown.

4. Use test light to check operation of clutch lever switch. When clutch pedal is depressed the switch must break the circuit (contacts open). When foot is removed from clutch pedal, switch must pass current (contacts closed).

5. Install splash shield and tighten attaching screws firmly.

BUFFER SCREW SWITCH REMOVAL

1. Disconnect wires from switch terminals (6, fig. 42).

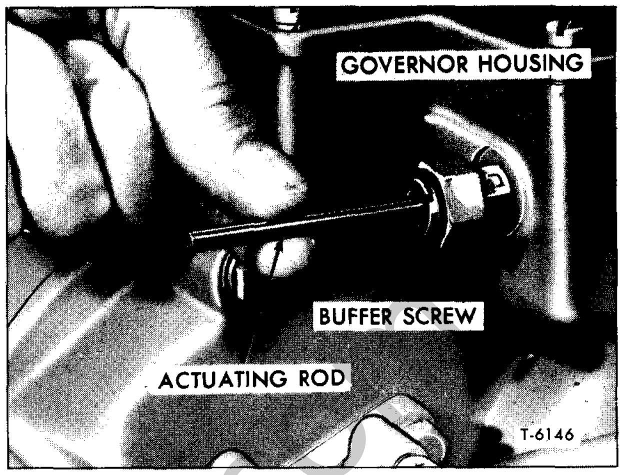


Figure 43—Removing or installing Switch Actuating Rod

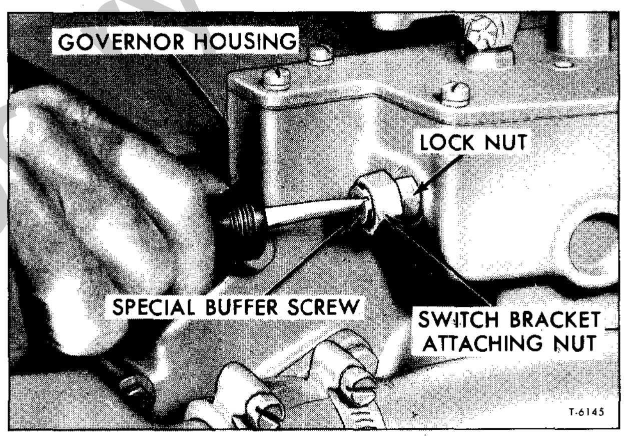


Figure 44—Buffer Screw Installation

2. Use two wrenches in manner shown in figure 42, and loosen nut (5) which secures switch bracket (4, fig. 42) to flanged buffer screw.

3. Thread nut off threads on bracket and remove switch and bracket assembly (fig. 45).

4. Remove actuating rod (fig. 43) from special buffer screw.

5. If necessary to replace and/or adjust buffer screw, use screwdriver as shown in figure 44 to turn buffer screw after loosening lock nut. Note that attaching nut and lock nut must be in position on buffer screw before the buffer screw is threaded into governor housing.

NOTE: Procedure for adjusting buffer screw is covered under "Engine Tune-Up Operations" earlier in this section.

BUFFER SCREW SWITCH INSTALLATION

1. Insert actuating rod (fig. 43), small end first, into buffer screw.

2. Position buffer screw switch and bracket

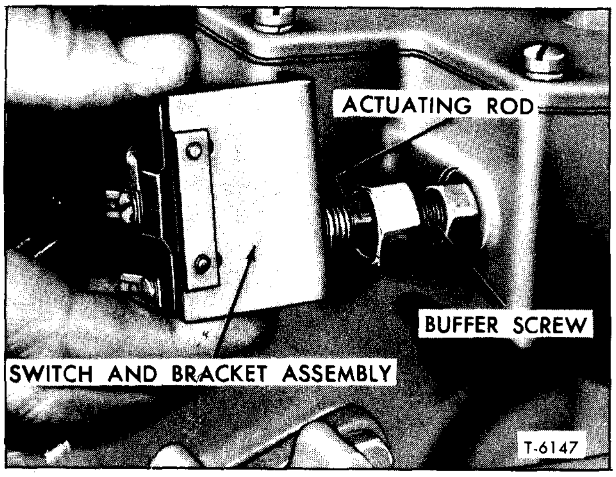


Figure 45—Removing or Installing Switch and Bracket Assembly at Buffer Screw

assembly at buffer screw (fig. 45), and start nut on bracket threads. Turn switch bracket so terminal spades point toward rear of engine and bracket is in vertical position as shown. Tighten attaching nut finger tight while holding bracket in position.

3. Use two wrenches in manner shown in figure 15, and while bracket is held to prevent turning, tighten attaching nut firmly.

4. Check position of diode (7, fig. 42). The diode lead from pointed end of diode must be connected to same terminal on switch as the feed wire to brake unit solenoid. Lead at opposite end of diode must be grounded to switch mounting screw.

5. Connect the two wires to switch terminals, then move engine throttle lever to "NO FUEL" position. Switch must actuate (click) when governor throttle lever is moved to "NO FUEL" position and again actuate when throttle lever is moved out of "NO FUEL" position. Loosen switch mounting screws and move the switch to make necessary adjustment. Slots (5, fig. 42) in switch bracket allow for positioning switch in relation to actuating rod (fig. 45).

NOTE: A 12-volt test light may be used to determine when switch is actuated. The control switch must be turned on to supply current to switch feed wire during test.

ENGINE BRAKE TROUBLE DIAGNOSIS CHART

PROBLEM	PROBABLE CAUSE	REMEDY
Engine Fails to Start.	1. Solenoid valves stuck in "On" position.	1. Be sure electric current is "Off" to Engine Brakes. If solenoid valve remains "On" with current off, replace the supply housing assembly.
Sudden Drop in Engine Lube Oil Pressure.	1. Oil inlet supply seal missing, or damaged.	1. Replace seal.
	2. Solenoid valve seal missing, or damaged.	2. Replace supply housing.
	3. Fuel pipe leakage.	3. Check fuel pipe nuts for tightness. Torque requirement is 12-15 foot-pounds. Inspect fuel pipe for damage, especially at flare end. Replace if defective. Change engine lube oil.
One or Two Cylinders Fail to Brake. (Loss of Braking Horsepower.)	1. Slave piston control valve stuck in "Off" (down) position.	1. Remove control valve; clean valve and bore. Replace valve, if necessary.
	2. Slave piston control valve failure.	2. Remove valve, clean bore and replace with new valve.
	3. Slave piston clearance adjustment incorrect.	3. Adjust slave piston clearance.
	4. Engine brake housing oil connectors or seals leaking.	4. Replace defective oil connector seals.

ENGINE BRAKE TROUBLE DIAGNOSIS CHART (CONT'D)

PROBLEM	PROBABLE CAUSE	REMEDY
Supply housing solenoids do not control braking operation.	1. Solenoid seal missing, or damaged.	1. Install supply housing assembly with functioning components.
Solenoids Will Not Energize.	1. Circuit breaker(fig. 34) opening.	1. Check for short circuit in wiring. Repair wiring and/or replace circuit breaker.
	2. Switch at clutch lever and/or at buffer screw failed, or out-of-adjustment.	2. Adjust switches for proper operation. Replace switch, if defective.
Engine Brake Slow to Operate.	1. Lube oil cold and too thick.	1. Allow engine to warm up before operating brakes.
	2. Solenoid valve filter screen clogged, or seals damaged.	2. Install good supply housing assembly.
	3. Lube oil contaminated.	3. Check for dirt in lube oil. Change oil if necessary.
	4. Switch operation sluggish.	4. Readjust or replace switch. Check for proper operation of throttle and clutch return springs.
One or More Cylinders Fail to Stop Braking or Engine Stalls.	1. One or more slave piston control valves stuck in "On" position.	1. Check control valve for binding, remove, clean, and replace if necessary. Check lube oil for dirt.
	2. Solenoid valve exhaust passage plugged.	2. Clean oil exhaust port in bottom of supply housing.
	3. Clutch switch stuck in the "On" position.	3. Check switch condition. Replace, if necessary.
	4. Buffer screw switch set too tight.	4. Reposition switch and check switch operation.
No Engine Braking.	1. Circuit breaker opening, or defective.	1. Check for short circuit in wiring harness or solenoid lead - replace circuit breaker.
	2. Low engine oil pressure.	2. Minimum oil pressure required is 25 psi.
	3. Switches misadjusted, or defective.	3. Readjust or replace switches.
Engine Misses or Loses Power.	1. Slave piston adjustment too tight.	1. Reset slave piston clearance to 0.066-inch as directed in text.

RECOMMENDED ENGINE BRAKE TORQUE VALUES

PART	TORQUE
Exhaust Valve Bridge Adjusting Screw Lock Nut. (Must not be tightened while bridge is installed in engine.) Hold Bridge in Vise When tightening Nut.	20-25 Ft.-Lbs.
Engine Brake Hold-down Bolts	88-92 Ft.-Lbs.
Fuel Line Nut	12-15 Ft.-Lbs.
Slave Piston Adjusting Screw Lock Nut	15-18 Ft.-Lbs.

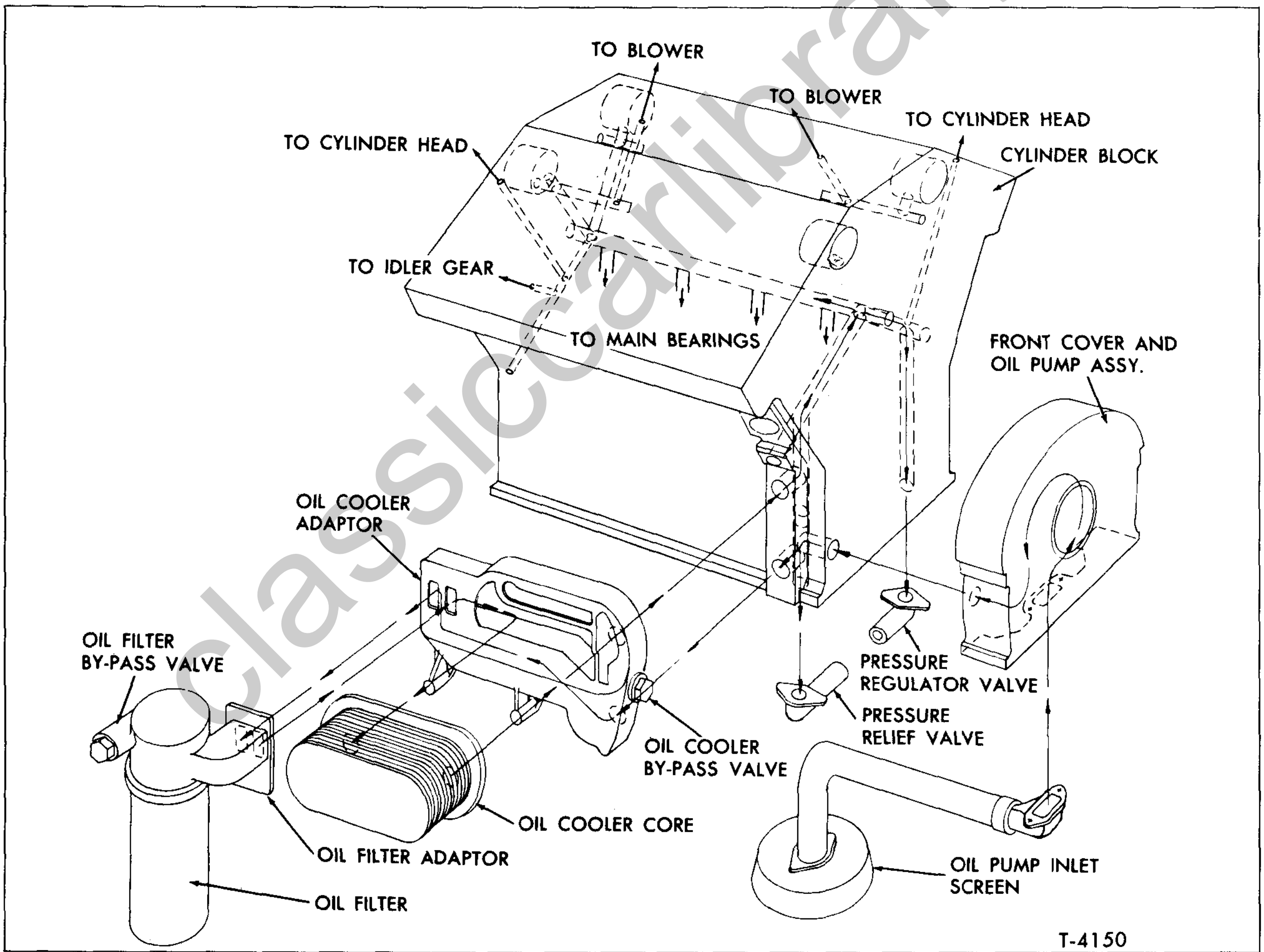


Figure 46—Lubrication Diagram (Schematic for 8V-71 N/NE Diesel Engines)

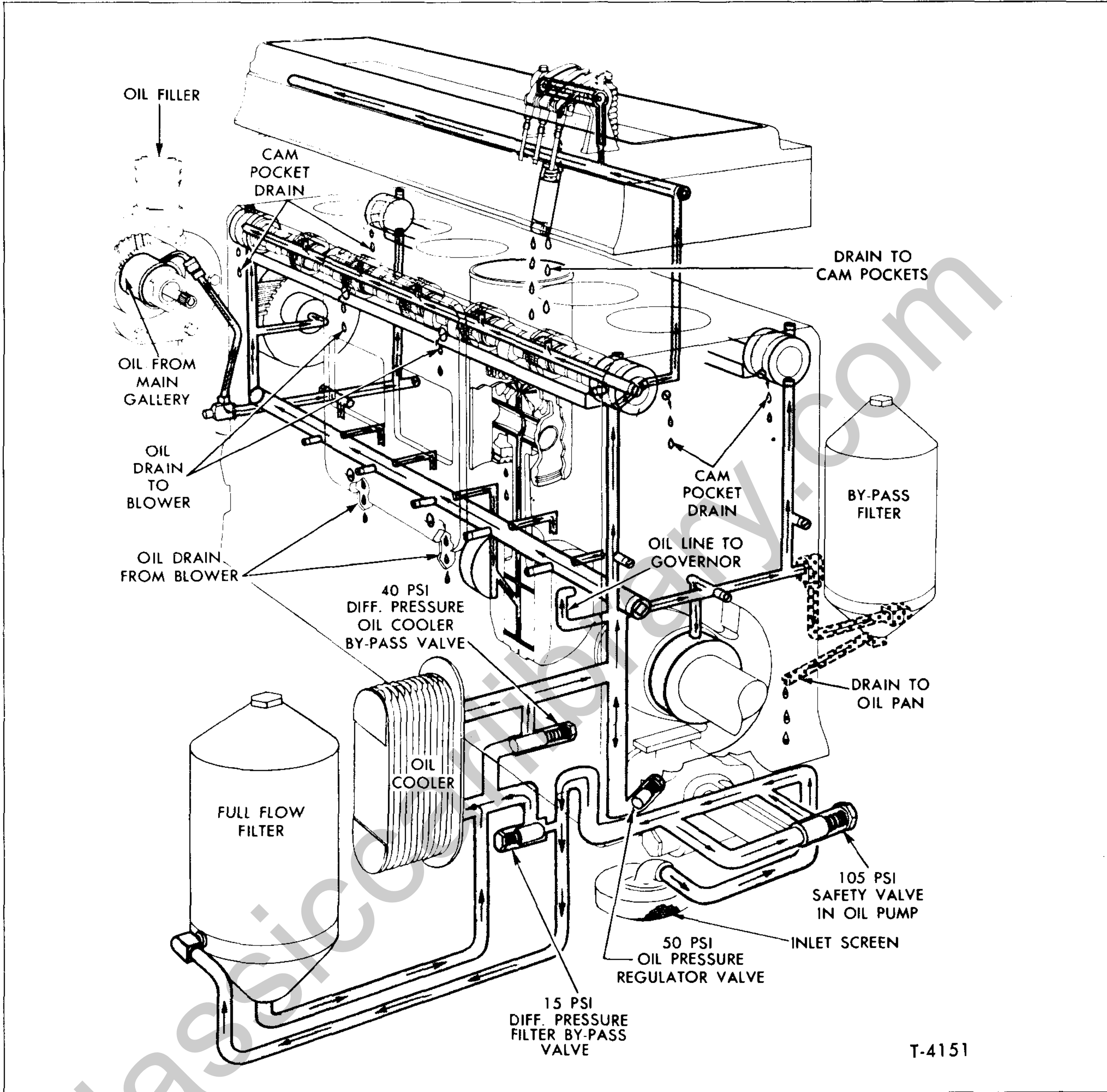


Figure 47—Lubrication Diagram (Schematic for In-Line 6-71 N/NE Diesel Engine)

ENGINE LUBRICATION

Figures 46 and 47 schematically illustrate the arrangement of oil galleries and passages for In-line and V-type engines.

All engines have an oil cooler unit, an oil filter, and pressure relief valves as shown. Oil pump output pressure is controlled by pressure regulator valve in oil pump body.

Inlet to oil pump is through a fixed type inlet screen in oil pan sump. All crankshaft and connecting rod bearings are pressure lubricated. Drilled passages carry oil to camshaft and balance shaft bearing.

Valve operating mechanism is lubricated from an oil gallery in cylinder head which is supplied with oil from cylinder block oil gallery. Oil is supplied to rocker arm shafts through holes drilled at lower ends of rocker arm shaft bracket bolts.

Excess oil from rocker arms lubricates lower ends of push rods and cam followers. Camshaft lobes are splash lubricated from oil which collects in pockets below camshaft(s).

TORQUE WRENCH SPECIFICATIONS

Torque figures shown are at various points indicated with threads clean and dry unless otherwise indicated.

Item	Ft.-Lbs.
Cylinder Head Bolts and Nuts	190-200*
Exhaust Manifold Stud Nuts	30-35
Rocker Arm Shaft Bracket Bolts	90-100
Pulley and Damper to Crankshaft Bolt	290-310
Oil Filter Center Bolt	40-50
Oil Pan Drain Plug	35-40
Lifting Bracket Bolts (In-Line Engine)	55-60
Rack Control Tube Bracket Bolts	10-12
Front Cover Bolts	
3/8-24	25-30
1/2-13	80-90
Oil Pan Bolts	10-12
Valve Bridge Adjusting Screw Lock Nut	25-30

* Bolt and stud threads, nuts, and bolt head contact areas coated with International Compound #2 or equivalent. International Compound #2 is available in quart containers - Part Number 5198563.

The "DIAGNOSIS AND TROUBLESHOOTING" section contained on pages 6C-49 through 6C-52 in this manual, may be used in diagnosing and correcting engine malfunctions in diesel engine models.

DIAGNOSIS AND TROUBLESHOOTING

(53 AND 71 SERIES DIESEL ENGINES)

Contents of this section are listed in Index below:

TESTING AND DIAGNOSIS

Certain abnormal conditions which sometimes interfere with satisfactory engine operation, together with methods of determining cause of such conditions, are covered on the following pages.

SATISFACTORY ENGINE OPERATION DEPENDS PRIMARILY ON:

1. The presence of an adequate supply of air compressed to a sufficiently high compression pressure.
2. The injection of the proper amount of fuel at the right time.

Lack of power, uneven running, excessive vibration, stalling at idle speed, and hard starting, may be caused by either low compression, faulty injection in one or more cylinders, or lack of sufficient air.

Since proper compression, fuel injection and the proper amount of air are important to good engine performance, detailed procedures for their investigation are given as follows:

LOCATING A MISFIRING CYLINDER
(Refer to Fig. 1)

1. Start the engine and run it at part load until it reaches normal operating temperature.
2. Stop the engine and remove the valve rocker cover(s). Discard the gasket(s).
3. Check the valve clearance 0.024" for the 53 Series engine and 0.014" for 71 Series engine as described earlier in this section.
4. Start the engine and hold an injector follower down with a screwdriver, to prevent operation of the injector. If the cylinder has been misfiring, there will not be any noticeable difference in the sound and operation of the engine. If the cylinder has been firing properly, there will be a noticeable difference in the sound and operation when the injector follower is held down. This is

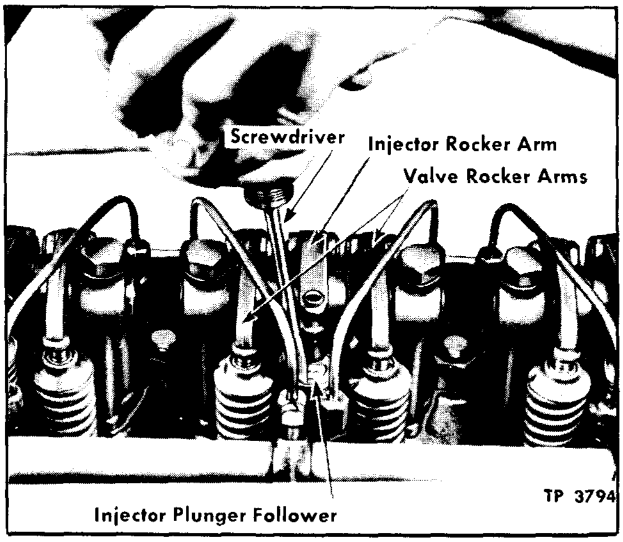


Figure 1—Locating a Misfiring Cylinder

similar to short-circuiting a spark plug in a gasoline engine.

5. If the cylinder is firing properly, repeat the procedure on the other cylinders until the faulty one has been located.

6. Provided the injector operating mechanism of the faulty cylinder is functioning satisfactorily, remove the fuel injector and install a new one by performing the removal and installation procedure outlined in ENGINE FUEL SYSTEM (SEC. 6M) of this manual.

If installation of a new injector does not eliminate misfiring, check the compression pressures.

CHECKING COMPRESSION PRESSURE
(Refer to Fig. 2)

1. Start the engine and run it at approximately one-half rated load until normal operating temperature is reached.

2. With the engine stopped, remove the fuel lines from the injector and the fuel connectors.

3. Remove the injector and install the adapter and pressure gauge from Diagnosis Kit (J-9531-01) (fig. 6). Refer to ENGINE FUEL SYSTEM (SEC. 6M) in this manual for procedure to remove injectors.

4. Use one of the fuel lines as a jumper connection between the fuel inlet and return passage to permit fuel to flow directly to the return passage.

5. Start the engine and run it at 600 rpm. Observe and record the compression pressure indicated on the gauge.

NOTE: Do not crank the engine with the starting motor to check the compression pressure.

Compression pressure is affected by altitude as follows:

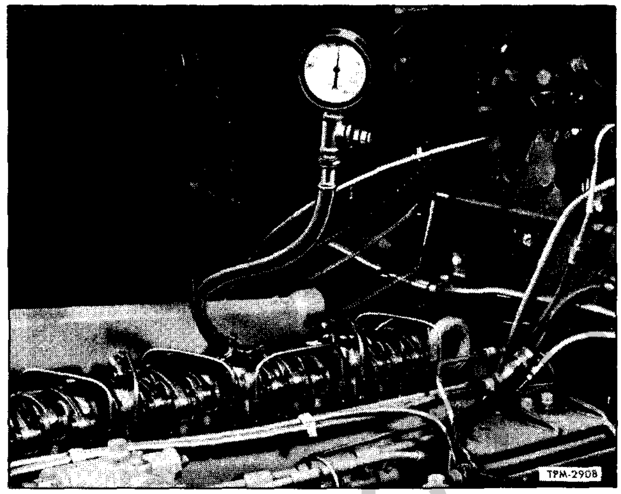


Figure 2—Checking Compression Pressure (Typical)

Min. Compression Pressure, Psi		Altitude, Feet
53 Series	71 Series	Above Sea Level
540	515	0
500	480	2,500
465	440	5,000
430	410	7,500
395	380	10,000

6. Perform Steps 2 through 5 on each cylinder. The compression pressure in any one cylinder should not be less than 515 psi on Series 71 (540 psi for 53 Series engine) at 600 rpm. In addition, the variation in compression pressures between cylinders of the engine must not exceed 25 psi at 600 rpm.

Low cylinder pressures may result from any one of several causes:

a. Piston rings may be stuck or broken. To determine the condition of the rings, remove the air box cover and inspect them by pressing on the compression rings with a blunt tool (fig. 3). A broken or stuck compression ring will not have a "spring like" action.

b. Compression pressure may be leaking past the cylinder head gasket, valve seats, injector tubes, or through a hole in the piston.

ENGINE OUT OF FUEL

The problem in restarting the engine after it is run out of fuel stems from the fact that after the fuel is exhausted from the fuel tank, fuel is then pumped from the primary fuel strainer and sometimes partially removed from the secondary fuel filter before the fuel supply becomes insufficient to sustain engine firing. Consequently, these components must be refilled with fuel and the fuel lines purged of air in order for the system to provide adequate fuel for the injectors.

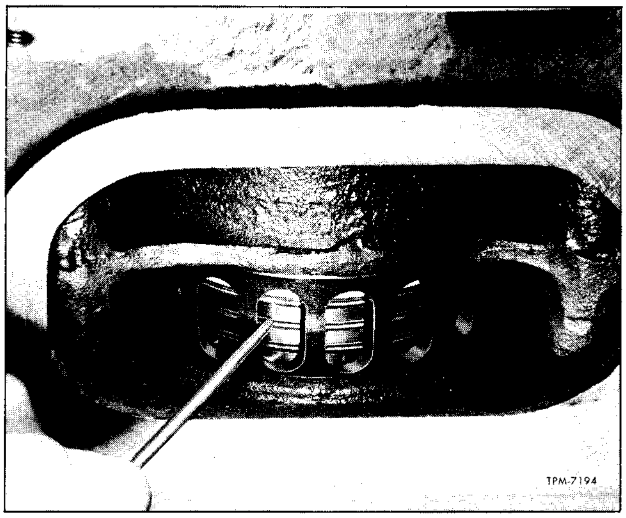


Figure 3—Inspection for Broken or Stuck Piston Rings (Typical)

When an engine is run out of fuel inadvertently, there is a definite procedure to follow for restarting the engine. The procedure is outlined below:

1. Fill the fuel tank with the recommended grade of fuel oil. If only partial filling of the tank is possible, add a minimum of ten gallons of fuel.
2. Remove the primary fuel strainer shell and element from the strainer cover and fill the shell with fuel oil. Install the shell and element.
3. Remove and fill the secondary fuel filter shell and element with fuel oil as in Step 2.
4. Start the engine. Check the filter and strainer for leaks.

NOTE: In some instances, it may be necessary to remove a valve rocker cover and loosen a fuel pipe nut in order to bleed trapped air from the fuel system. Be sure the fuel pipe is retightened securely before replacing the rocker cover.

Primer (J-5956) may be used to prime the entire fuel system. Remove the filter plug in the fuel filter cover and install the primer. Prime the system. Remove the primer and install the filter plug.

FUEL FLOW TEST (Fig. 4)

1. Disconnect the fuel return tube and hold the open end in a suitable container.
2. Start and run the engine at approximately 1200 rpm and measure the fuel flow from the return tube for one minute.

NOTE: At least .6 gallons of fuel on 53 Series and .9 gallons on 71 Series engine should flow from the return line per minute.

3. Be sure all line connections between the fuel supply and the pump are tight so no air will be drawn into the fuel system; then, immerse the end of the fuel return line into the fuel in the container.

Figure 4—Fuel Flow Test

Air bubbles rising to the surface of the fuel will indicate a leak on the suction side of the pump.

FUEL QUALITY

The quality of the fuel oil used for diesel engine operation is a major factor in satisfactory engine performance and life. The fuel oils selected must be clean, completely distilled, stable, and non-corrosive. Enlist the aid of your supplier in obtaining proper fuel oil. The responsibility for clean fuel lines with the fuel supplier as well as with the operator.

DISTILLATION RANGE, CETANE NUMBER, AND SULFUR CONTENT are three of the most important properties in the selection of diesel fuels for optimum combustion and minimum wear. Engine speed, load, and atmospheric temperature influence the selection of the fuels with respect to distillation range and cetane number. THE SULFUR CONTENT OF THE FUEL MUST BE AS LOW AS POSSIBLE, to avoid excessive deposit formation and premature wear.

FUEL PRESSURE TEST

The fuel pressure gauge is designed for use in checking fuel pressure at the injector with the engine in operation. Remove the jumper line from the injector to the return fuel manifold and connect the fuel gauge in place of the jumper line (fig. 5). Refer to "Fuel Pressure" chart following:

FUEL PRESSURE					
	SPEED (RPM)				
Engine	1200	1800	2100	2200	2600
6V-53				45-70	45-70
6-71	30-65	45-70	45-70		
8V-71	45-70	45-70	45-70		

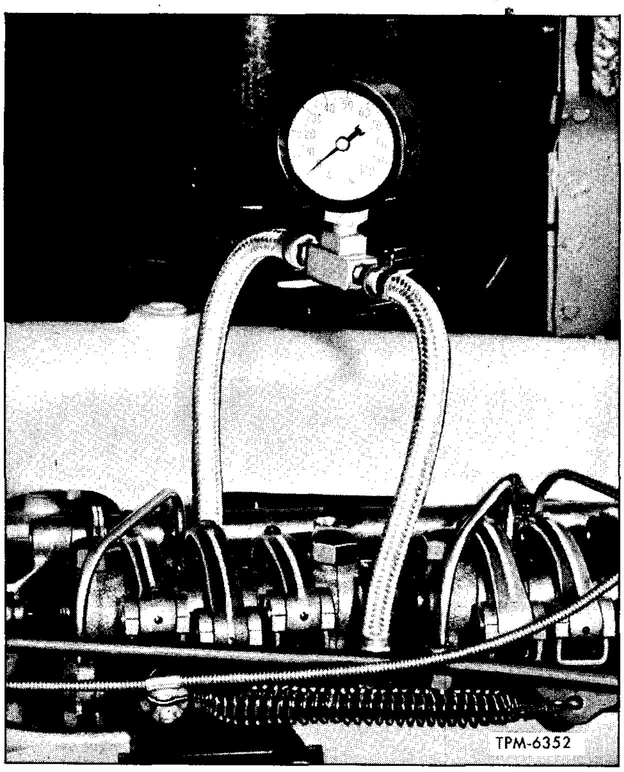


Figure 5—Checking Fuel Pressure at Injector

ENGINE OIL PRESSURE TEST

To check operating oil pressure connect the 0-100 pressure gauge to the oil gallery or into oil line from gallery to oil filter.

Start engine. For satisfactory pressures refer to following chart:

OIL PRESSURE					
	SPEED (RPM)				
Engine	1200	1800	2100	2200	2600
6V-53				40-60 Min. 30	40-60 Min. 32
6-71	30-60 Min. 18	38-60 Min. 27	40-60 Min. 30		
8V-71	35-55 Min. 25	50-70 Min. 28	50-70 Min. 30		

COOLING SYSTEM

Refer to ENGINE COOLING SYSTEM (SEC. 6K) of this manual for cooling system checks.

CRANKCASE PRESSURE

The crankcase pressure indicates the amount of air that has passed between the oil control rings and the liner into the crankcase, most of which is clean air from the air box. A slight pressure in the crankcase is needed to prevent the entrance of dust.

A loss of engine lubricating oil through the breather tube, crankcase ventilator, or dipstick hole in the cylinder block is indicative of excessive crankcase pressure. The maximum crankcase pressure is shown in the following chart:

CRANKCASE PRESSURE (Max. in Inches of Water)				
	SPEED (RPM)			
Engine	1200	1800	2100	2600
6V-53				1.0
6-71	2.0	2.8	3.1	
8V-71	0.5	1.1	1.5	

The causes of high crankcase pressure may be traced to excessive blow-by due to worn piston rings, a hole or crack in a piston crown, loose piston pin retainers, worn blower oil seals, defective blower, cylinder head or end plate gaskets, or excessive exhaust back pressure. Also, the breather tube or crankcase ventilator should be checked for obstructions.

The crankcase pressure may be checked with the manometer in the Engine Diagnosis Test Kit (J-9531-01) (fig. 6). The manometer should be connected to the oil level dipstick opening in the cylinder block. Check the readings obtained at various engine speeds with the specifications in the chart.

EXHAUST BACK PRESSURE

A slight pressure in the exhaust system is normal. However, excessive exhaust back pressure seriously affects engine operation. It may cause an increase in the air box pressure with a resultant loss of efficiency of the blower. This means less air for scavenging which results in poor combustion and higher temperatures. The maximum exhaust back pressure (no-load) is shown in the following chart:

EXHAUST BACK PRESSURE - NO LOAD (Max. in Inches of Mercury)					
	SPEED (RPM)				
Engine	1200	1800	2000	2100	2600
6V-53					2.7
6-71	1.2	2.8	3.5	3.5	
8V-71	.09	2.1	2.6	2.6	

Due to variations in exhaust systems (horizontal or vertical stacks) the above chart is typical.

Causes of high exhaust back pressure are usually a result of an inadequate or improper type of muffler, an exhaust pipe which is too long or too small in diameter, an excessive number of sharp bends in the exhaust system, or obstructions such as excessive carbon formation or foreign matter in the exhaust system.

The exhaust back pressure, measured in inches of mercury, may be checked with the manometer in the Engine Diagnosis Test Kit (J-9531-01) (fig. 6). The manometer or pressure gauge is connected to the exhaust manifold by removing the 1/8" pipe plug which is provided for that purpose. If there is no opening provided, one can be made by drilling an 11/32" hole in the exhaust manifold companion flange and tapping a 1/8" pipe thread.

Check the readings obtained at various speeds (no load) with the specifications in the "Exhaust Back Pressure" chart.

AIR BOX PRESSURE

Proper air box pressure is required to maintain sufficient air for combustion and scavenging of the burned gases. Low air box pressure is caused by a high air inlet restriction, damaged blower rotors, an air leak from the air box, such as leaking end plate gaskets, a clogged blower air inlet screen.

AIR BOX PRESSURE (Min. in Inches of Mercury) (Max. Exhaust Back Pressure (Full Load)				
	SPEED (RPM)			
Engine	1200	1800	2100	2600
6V-53				8.4
6-71	3.2	7.6	10.1	
8V-71	2.3	6.4	8.2	
(Zero Exhaust Back Pressure)				
6V-53				5.2
6-71	1.7	4.3	6.0	
8V-71	1.1	3.8	5.0	

Lack of power or black or grey exhaust smoke are also indications of low air box pressure.

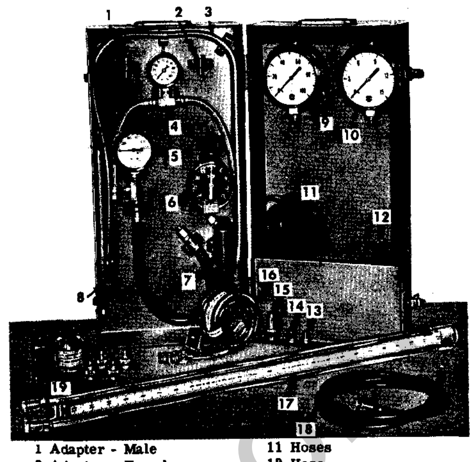
To check the air box pressure connect a manometer to the air box drain tube.

Check the readings obtained at various speeds with the specifications in the chart.

AIR INLET RESTRICTION

Excessive restriction of the air inlet will affect the flow of air to the cylinders and result in poor combustion and lack of power. Consequently, the restriction must be kept as low as possible considering the size and capacity of the air cleaner. An obstruction in the air inlet system or dirty or damaged air cleaners will result in a high blower inlet restriction.

The air inlet restriction may be checked with a water manometer connected to a fitting in the air intake ducting located two inches above the air inlet housing. When practicability prevents the insertion of a fitting at this point, the manometer may be connected to the engine air inlet housing.



1 Adapter - Male
2 Adapter - Female
3 Tachometer Cable
4 Fuel Pressure Gauge
5 Compression Gauge
6 Tachometer
7 Compression Gauge Adapter
8 Thermometer
9 Pressure Gauge 0-100#
10 Pressure Gauge 0-15#
11 Hoses
12 Hose
13 Connector
14 Bushing
15 Adapter
16 Manometer - Mercury
17 Manometer - Water
18 Hose
19 Mercury

Figure 6—Diagnosis Test Kit

The restriction at this point should be checked at a specific engine speed. Then, the air cleaner and ducting should be removed from the air inlet housing and the engine again operated at the same speed while noting the manometer reading.

The difference between the two readings, with the air cleaner and ducting and without the air cleaner and ducting, is the actual restriction caused by the air cleaner and ducting.

Check the normal air intake vacuum at various speeds (at no-load) and compare the results with the following chart:

AIR INTAKE RESTRICTIONS (In Inches of Water) (Max. With Dirty Air Cleaner (Oil Bath or Dry)				
	SPEED (RPM)			
Engine	1200	1800	2100	2600
6V-53				24.5
6-71	12.4	25.0	25.0	
8V-71	12.4	25.0	25.0	
(Max. With Clean Air Cleaner (Oil Bath or Dry) With Precleaner)				
6V-53				14.7
6-71	8.7	13.4	15.9	
8V-71	8.7	13.4	15.9	
(Max. With Clean Air Cleaner (Dry) No Precleaner				
6V-53				9.2
6-71	5.2	9.1	11.5	
8V-71	5.2	9.1	11.5	

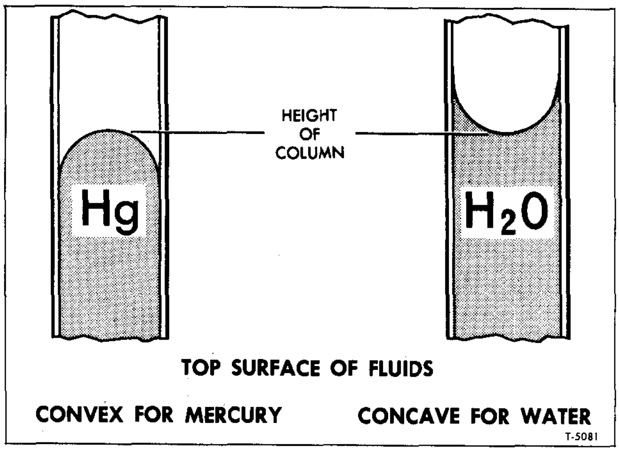


Figure 7—Comparison of Column Height for Mercury and Water Manometer

PROPER USE OF MANOMETER

The U-tube manometer is a primary measuring device indicating pressure or vacuum by the difference in the height of two columns of fluid.

Connect the manometer to the source of pressure, vacuum, or differential pressure. When the pressure is imposed, add the number of inches one column of fluid travels up to the amount the other column travels down to obtain the pressure (or vacuum) reading.

The height of a column of mercury is read differently than that of a column of water. Mercury does not wet the inside surface; therefore, the top of the column has a convex meniscus (shape). Water wets the surface and therefore has a concave meniscus. A mercury column is read by sighting horizontally between the top of the convex mercury surface (fig. 7) and the scale. A water manometer is read by sighting horizontally between the bottom of the concave water surface and the scale.

Should one column of fluid travel further than the other column, due to minor variations in the inside diameter of the tube or to the pressure imposed, the accuracy of the reading obtained is not impaired.

The manometer reading may be converted into other units of measurement by use of the pressure conversion chart.

PRESSURE CONVERSION CHART

1" water	=	.0735" mercury
1" water	=	.0361 psi
1" mercury	=	.491 psi
1" mercury	=	13.6" water
1" psi	=	27.7" water
1" psi	=	2.036" mercury

All Tune-up Operations and Adjustments Should Be Performed Carefully and In Proper Sequence

TROUBLESHOOTING

The satisfactory performance of a Diesel engine depends on two items of foremost importance, (1) Sufficiently high compression pressure, and (2) The injection of the proper amount of fuel at the right time.

The first one of these items depends entirely on pistons, piston rings, valves, and valve operating mechanism; the second item depends on injectors and their operating mechanism, and fuel system.

Lack of engine power, uneven running, excessive vibration, and tendency to stall when idling may be caused by either a compression loss or faulty injector operation.

The causes of trouble symptoms may be varied; therefore a hit-and-miss search should be avoided. A proper diagnosis of symptoms is an orderly process of diagnosing the symptoms. An "orderly process" means to check the most probable common cause first; then proceed with the next probable cause.

The quick reference Trouble Shooting Charts on pages following list symptoms, with probable causes, and remedies. References are made to other charts, also to various sections in this manual, which list correct remedies and procedures.

HARD STARTING

LOW STARTING R.P.M.

IMPROPER LUBE OIL VISCOSITY—Refer to "Lubrication System" (SECTION O).

INFREQUENT OIL CHANGES—Change oil at recommended intervals.

LOW BATTERY OUTPUT—Check for the following:

1. Poor or Shorted Connections—Properly connect or replace leads and terminals.
2. Undercharged or Defective—Recharge or replace battery.
3. Low Ambient Temperature—Use a starting aid.

FAULTY STARTER OR LOOSE STARTER CONNECTIONS—Replace starter or tighten connections.

LOW COMPRESSION

EXHAUST VALVES STICKING OR BURNED—Overhaul cylinder head.

COMPRESSION RINGS WORN OR BROKEN—Overhaul cylinder liner assemblies.

CYLINDER HEAD GASKET LEAKING—Replace cylinder head gasket.

IMPROPER VALVE CLEARANCE ADJUSTMENT—Adjust valve clearance.

BLOWER NOT FUNCTIONING—Check blower drive shaft and couplings.

EMERGENCY SHUT-OFF VALVE PARTIALLY OR COMPLETELY CLOSED—Reset.

FUEL

AIR LEAKS, FLOW OBSTRUCTION, FUEL PUMP—Refer to "No Fuel or Insufficient Fuel" chart.

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HARD STARTING—Cont.

FUEL—Cont.

INJECTOR RACKS NOT IN FULL FUEL POSITION—Check control tube for binds and reset governor and control rack, if necessary.

FUEL TANK OR FUEL FILTER EMPTY—Fill fuel tank or prime filter.

IMPROPER GRADE AND TYPE FUEL—Refer to Current Diesel Fuel Oil Service Bulletin.

DILUTED FUEL—Check storage and handling methods.

IMPROPERLY FILTERED OR RESTRICTED FUEL FLOW—Refer to "No Fuel or Insufficient Fuel".

AIR IN FUEL SYSTEM -Bleed air from fuel system at secondary fuel filter.

ABNORMAL ENGINE OPERATION

UNEVEN RUNNING OR FREQUENT STALLING

CYLINDERS CUTTING OUT—Check for the following:

1. Valve Clearance Set Incorrectly—Readjust valve clearance as directed under "Valve Lash" in "Engine Tune-up" section.
2. Insufficient Fuel—Refer to "No Fuel or Insufficient Fuel".
3. Faulty Injector—Refer to "Injector Tests" under "Fuel Injectors" in "Fuel System" (SECTION 6C).

COOLING SYSTEM TEMPERATURE BELOW NORMAL—Refer to "Abnormal Engine Coolant Temperatures".

NO FUEL OR INSUFFICIENT FUEL—Refer to "No Fuel or Insufficient Fuel".

FAULTY INJECTORS—

1. Improper Timing of Injectors—Retime injectors as directed under "Injector Timing" in (Section 6C).
2. Incorrect Rack Setting—Readjust injector racks as outlined in (Section 6C).
3. Injector Spray Tip Leaks—Replace fuel injector.

CYLINDER PRESSURES LOW—Refer to "Hard Starting".

GOVERNOR INSTABILITY (HUNTING)—Check for the following:

1. Governor Instability—Perform engine tune-up.
2. Binding Injector Rack—Replace injector.
3. Faulty Adjustments—Perform tune-up operations in sequence as instructed in "Engine Tune-up" section.

IMPROPER GRADE AND TYPE FUEL—Refer to Current Diesel Fuel Oil Service Bulletin.

DILUTED FUEL—Check storage and handling methods.

IMPROPERLY FILTERED OR RESTRICTED FUEL FLOW—Refer to "No Fuel or Insufficient Fuel".

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ABNORMAL ENGINE OPERATION—Cont.

DETONATION

OIL PICKED UP BY AIR STREAM—Check for the following:

1. Oil Pull Over From Air Cleaners—Remove, clean, and fill air cleaners with engine oil to proper oil level.
2. Accumulation in Air Box—Clean air box and air box drain tubes.
3. Defective Blower to Cylinder Block Gasket—Remove blower and gasket and install a new gasket and reinstall blower.
4. Leaking Blower Oil Seals—Remove and overhaul blower.

LOW COOLANT TEMPERATURE—Refer to "Abnormal Engine Coolant Temperatures" chart.

FAULTY INJECTORS—Check for the following:

1. Improper Timing—Retime injectors as directed under "Injector Timing" in (Section 6 C).
2. Check Valve Leaking—Replace injector.
3. Spray Tip Holes Enlarged—Replace injector.
4. Broken Spray Tip—Replace injector.

LACK OF POWER

IMPROPER ENGINE ADJUSTMENTS—Check for the following:

1. Governor Gap Set Incorrect—Perform tune-up operations as directed in (Section 6 C).
2. Rack Setting Incorrect—Perform tune-up operations as directed in (Section 6 C).
3. Injector Timing Incorrect—Time fuel injectors as directed under "Injector Timing" in (Section 6C).
4. Valve Clearance Set Incorrectly—Readjust valve clearance as directed under "Valve Lash" in "Engine Tune-up" section.

INSUFFICIENT FUEL—Refer to "No Fuel or Insufficient Fuel".

INSUFFICIENT AIR—Check for the following:

1. Air Cleaners Damaged or Clogged—Remove and clean, repair or replace damaged parts.
2. Cylinder Liner Air Inlet Ports Clogged—Clean cylinder liner ports.
3. Low Compression—Refer to "Low Compression" in "Hard Starting".
4. Blower Air Intake Obstructed—Check and clean air cleaner and air inlet horn and screen.
5. Excessive Exhaust Back Pressure—Inspect exhaust pipe and muffler and replace if damaged.

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EXHAUST SMOKE ANALYSIS

(Checks to be made with water outlet temperature of 160°F. minimum)

BLACK OR GRAY SMOKE

INCOMPLETELY BURNED FUEL—Check for the following:

1. Insufficient Combustion Air—High exhaust back pressure (measured with manometer)—Check exhaust piping and muffler for obstruction.
2. Restricted Air Inlet—
   a. Cylinder liner ports clogged—Clean liner ports.
   b. Air cleaner clogged or damaged—Remove and clean, repair or replace damaged parts.
   c. Emergency stop not completely open—Check operation of emergency shutdown device and adjust if necessary.
   d. Blower to air horn screen clogged—Remove screen and clean.

EXCESSIVE FUEL OR IRREGULAR FUEL DISTRIBUTION—Check for the following:

1. Improper Injector Rack Setting—Perform operations as directed in (Section 6 C).
2. Improper Timing of Injectors—Time fuel injectors as directed under "Injector Timing" in (Section 6 C).
3. Faulty Injectors—Replace injectors.
4. Lugging Engine—Correct driving practices.

IMPROPER GRADE OF FUEL—Refer to Current Diesel Fuel Oil Service Bulletin.

BLUE SMOKE

FUEL OR LUBRICATING OIL NOT BURNED IN CYLINDER (BLOWN THROUGH CYLINDER DURING SCAVENGING PERIOD)—Check for the following:

1. Internal Lubricating Oil Leaks—Refer to "High Lubricating Oil Consumption".
2. Pullover of Air Cleaner Oil—Oil level to high or to light viscosity.

FAULTY INJECTOR—Refer to "Uneven Running or Frequent Stalling" in "Abnormal Engine Operation".

COOLING SYSTEM TEMPERATURE BELOW NORMAL—Refer to "Abnormal Engine Coolant Temperatures".

WHITE SMOKE

MIS-FIRING CYLINDERS—Check for the following:

1. Faulty Injectors—Replace injectors.
2. Low Compression—Refer to "Hard Starting".
3. Low Cetane Fuel—Refer to Current Diesel Fuel Oil Service Bulletin.

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NO FUEL OR INSUFFICIENT FUEL

AIR LEAKS

LOW FUEL SUPPLY—Fill fuel tank.

LOOSE CONNECTIONS OR CRACKED FUEL LINES—Tighten connections and replace defective lines and fittings, then make "Fuel Flow Test."

DAMAGED FUEL OIL STRAINER GASKET—Replace gasket.

FAULTY INJECTOR TIP ASSEMBLY—Make "Fuel Pressure and Flow Tests" after ascertaining that all fuel lines and connections are assembled correctly. Replace faulty injectors.

FUEL FLOW

FUEL FILTER OR LINES RESTRICTED—Make "Fuel Pressure and Flow Tests" and clean primary filter element or replace secondary and injector filter elements, also fuel lines if necessary.

TEMPERATURE LESS THAN 10°F. ABOVE THE POUR POINT OF FUEL—Refer to Current Diesel Fuel Oil Service Bulletin.

RESTRICTED FITTING MISSING FROM RETURN MANIFOLD—Install new restricted fitting.

FAULTY FUEL PUMP

RELIEF VALVE NOT SEALING—Make "Fuel Pressure and Flow Tests" and clean and inspect valve and seat assembly.

WORN GEARS OR PUMP HOUSNG—Replace gear and shaft assembly and fuel pump if housing is damaged.

FUEL PUMP NOT ROTATING—Check condition of fuel pump drive and blower drive and replace if necessary.

HIGH LUBRICATING OIL CONSUMPTION

EXTERNAL LEAKS

OIL LINES AND CONNECTIONS LEAKING—Tighten or replace defective parts.

GASKET OR OIL SEAL LEAKS—Replace defective gaskets or oil seals.

HIGH CRANKCASE PRESSURE—Refer to "High Crankcase Pressure".

EXCESSIVE OIL IN AIR BOX—Refer to "Detonation" in "Abnormal Engine Operation".

INTERNAL LEAKS

BLOWER OIL SEAL LEAKING—Remove and overhaul blower.

OIL COOLER CORE LEAKING—Replace oil cooler core and use a good cooling system cleaner to remove oil from water passages.

ENGINE BLOCK END PLATE GASKETS LEAKING—Replace block to end plate gaskets.

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HIGH LUBRICATING OIL CONSUMPTION—Cont.

OIL CONTROL AT CYLINDER

OIL CONTROL RINGS WORN, BROKEN, OR IMPROPERLY INSTALLED—Replace rings on piston.

PISTON PIN RETAINER LOOSE—Replace piston retainer and defective parts.

SCORED LINERS, PISTONS, OR OIL RINGS—Remove and replace defective parts.

PISTON AND ROD ALIGNMENT (CAUSED BY WORN CRANKSHAFT THRUST WASHERS) —Replace worn and defective parts.

EXCESSIVE OIL IN CRANKCASE—Fill only to "FULL" mark on dipstick.

LOW OIL PRESSURE

(Check to be made with engine water outlet temperature of 160°F. minimum)

LUBRICATING OIL

SUCTION LOSS—Check oil level and bring to "FULL" mark on dipstick or correct installation angle.

LUBRICATING OIL VISCOSITY—Check for the following:

1. Wrong Viscosity Lubricating Oil—Refer to "Lubrication" (Section 0).
2. Plugged Oil Cooler—Clean oil cooler if oil temperature is abnormally high.
3. Fuel Oil Dilution—Check for fuel leaks at injector seal ring, and fuel jumper line connections.

PRESSURE GAUGE

FAULTY GAUGE—Replace gauge.

GAUGE LINE OBSTRUCTED—Remove and clean line, replace if necessary.

ORIFICE PLUGGED—Remove and clean orifice.

CIRCULATION

FILTER CLOGGED—Remove and clean or replace element.

COOLER CLOGGED—Remove oil cooler and clean.

COOLER BY-PASS VALVE NOT FUNCTIONING PROPERLY—Remove by-pass valve, clean valve and valve seat and inspect valve spring.

PRESSURE REGULATOR VALVE NOT FUNCTIONING PROPERLY—Remove pressure regulator valve and clean and inspect spring.

EXCESSIVE WEAR OF CRANKSHAFT BEARINGS—Change engine bearings, clean oil pan, refer to "Engine Oil Viscosity Chart" for proper grade, and change oil filter element.

GALLERY, CRANKSHAFT OR CAMSHAFT PLUGS MISSING—Replace plugs.

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LOW OIL PRESSURE—Cont.

OIL PUMP

INTAKE SCREEN PARTIALLY CLOGGED—Remove oil pan and screen, clean oil pan and screen, refer to "Engine Oil Viscosity Chart" and refill crankcase and change oil filter element.

RELIEF VALVE NOT PROPERLY FUNCTIONING—Remove and inspect valve, valve bore, and spring.

AIR INTAKE IN PUMP INLET SYSTEM—Disassemble piping and install new gaskets.

PUMP WORN OR DAMAGED—Remove pump, clean and replace defective parts.

LEAK PRESSURE SIDE—Remove pump and replace gasket.

EXCESSIVE CRANKCASE PRESSURE

CYLINDER BLOW-BY

CYLINDER HEAD GASKET LEAKING—Remove and replace head gaskets.

PISTON AND LINER DAMAGED—Remove and replace piston and liner.

PISTON RINGS WORN OR BROKEN—Remove and replace piston rings.

PISTON PIN RETAINER LOOSE—Remove.

BREATHER RESTRICTION

OBSTRUCTION OR DAMAGE TO BREATHER—Clean, repair or replace breather.

AIR FROM BLOWER OR AIR BOX

DAMAGED BLOWER-TO-BLOCK GASKET—Remove blower and gasket, replace with new gasket.

ENGINE BLOCK END PLATE GASKETS LEAKING—Replace block to end plate gaskets.

BLOWER OIL SEAL LEAKING—Remove and overhaul blower.

EXCESSIVE EXHAUST BACK PRESSURE

EXCESSIVE MUFFLER RESISTANCE—Repair or replace muffler.

OBSTRUCTION IN MUFFLER—Repair or replace muffler.

EXHAUST PIPING—Replace damaged pipes.

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ABNORMAL ENGINE COOLANT TEMPERATURES

ABOVE NORMAL OPERATING TEMPERATURES

INSUFFICIENT HEAT TRANSFER—Check for the following:

1. Scale Deposits in Cooling System—Clean cooling system with a good cooling system cleaner and flush thoroughly.
2. Radiator Core Plugged Preventing Normal Air Flow—Clean outside of radiator core.
3. Fan Belt Loose—Tighten fan belt.
4. Improper Installation—Improper shrouding of fan.

POOR CIRCULATION—Check for the following:

1. Coolant Level too Low—Fill radiator to filler neck.
2. Hoses Collapsed or Disintegrated—Replace hoses.
3. Thermostat Damaged—Replace thermostat.
4. Water Pump Impeller Loose on Shaft—Replace impeller or shaft.
5. Inadequate Water Supply on Suction Side of Pump—Caused by:
   a. Radiator Clogged—Clean radiator.
   b. Combustion Gases in Cooling Water—Replace all head gaskets and inspect cylinder heads for cracks or injector tube leaking.
   c. Air in Cooling System—Caused by:
      (1) Air Leak on Suction Side of Water Pump—Replace defective parts.
      (2) Thermostat Housing Vent Holes Plugged—Clean.

BELOW NORMAL

POOR CIRCULATION—Check for the following:

1. Thermostat Inoperative—Replace thermostat.
2. Thermostat Seat Damaged—Replace thermostat.
3. Thermostat Seal Damaged—Replace seal.

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SECTION 6D

ENGINE MOUNTINGS

GENERAL DESCRIPTION

Cushion-type mountings are used at both front and rear of engine on all vehicles. The various types of mountings are illustrated throughout this section and the accompanying chart lists torques to be used in tightening mounting bolts and bracket bolts.

GENERAL MAINTENANCE

Engine mountings should be inspected periodically and if found damaged or deteriorated they should be replaced.

IMPORTANT: Broken or deteriorated mounts can cause misalignment and eventual destruction of certain drive train components. Also, when a single mounting failure occurs, the remaining mountings are subjected to abnormally high stresses.

When inspecting engine mounts, check all attaching bolts and nuts for tightness.

MOUNTING CUSHION REPLACEMENT

IMPORTANT: When supporting engine to replace a mount, raise engine only to height required to provide clearance for mounting removal. In some cases it may be necessary to drain cooling system and disconnect hoses to avoid damage when engine is raised. Use care to see that control linkage and wiring are not damaged as a result of raising engine.

NOTE: When replacing a single front mounting on engines having a two-point type front mounting, both mountings should be detached before attempting to raise the engine. Failure to do this will place excessive stress on the attached mounting when engine is raised.

The instructions for replacing mountings which follow cover general procedures on various types of engines as illustrated in appropriate illustrations.

ENGINE MOUNTING TORQUE CHART

ENGINE FRONT MOUNTINGS

MODELS	BRACKET-TO-ENGINE BOLTS	MOUNTING BOLTS AND/OR NUTS	MOUNTING BRACKET-TO-FRAME BOLT NUTS
HM, JM, TM 80	60-70	95-105	—
HV, JV 70	40-50	Top 70-80 Bottom 65-75	—
TV 70	Upper 33-45 Lower 55-75	55-75	60-90
HE, TE, JE 90	70-80	70-80	—
MH 90	85-105	Bolt 110-140 Nut 70-90	—
MI, JI, HI 90	170-180	70-80	45-50
HN, JN 90	170-180*	—	170-180
DI, FI 90 W/AC	⅜″ 25-30 ½″ 80-90	180-190	—
DI, FI 90 WO/AC	—	140-160	190-210
FN, DN 90	170-180*	—	170-180
FC, DC 90	170-180*	—	170-180

*Top Support to Lower Support Bolts

ENGINE REAR MOUNTINGS

MODELS	BRACKET-TO-ENGINE BOLTS	MOUNTING BOLTS AND/OR NUTS	MOUNTING BRACKET-TO-FRAME BOLT NUTS
HM, JM 80	160-170	70-80	40-50
TV 70	80-120	130-180	130-180
HV, JV 70	190-210	180-190	50-60
MI, HI, JI 90	190-220**	85-105	50-60
MH 90	300-320	60-70	45-55
HN, JN 90	300-320	85-105	50-60
FI, DI 90	300-320	85-105	50-60
FH, DH 90	300-320	85-105	50-60
FN, DN 90	300-320	85-105	50-60
FC, DC 90	300-320	85-105	50-60

*This torque is for ½-13 bolts. The ⅜-16 bolts also used at bracket must be tightened to 25 to 30 foot pounds.
**This torque for standard transmission. With optional Fuller transmission torque must be 300-320 foot pounds.

ENGINE FRONT MOUNTING REPLACEMENT

TV70 MODEL (WITH 6V-53 ENGINE)

NOTE: Key numbers in following text refer to figure 1.

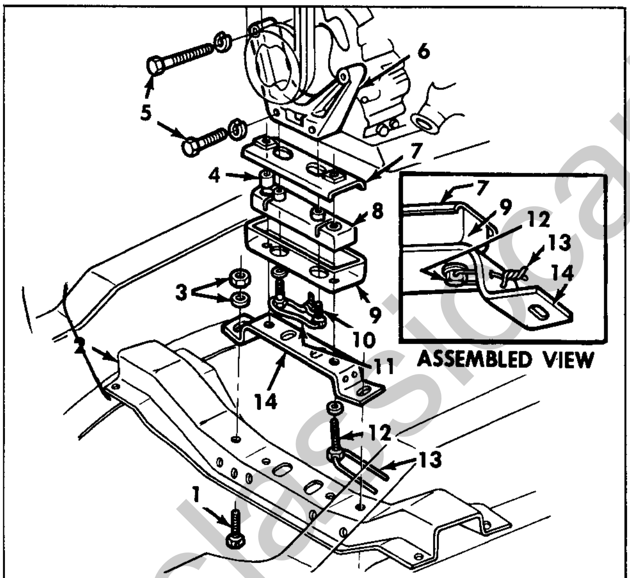
REMOVAL

1. Cut and remove lock wire (11) which secures two mounting bolts (10), then remove the mounting bolts.
2. Raise front of engine far enough to take weight off front mounting.
3. Remove two bolts (1) attaching bracket (14) and mounting assembly to crossmember, then remove bracket and mounting assembly.
4. Remove lock wires (13) securing bolts (12), and remove bolts (12) which are threaded into weld-nuts on plate (7). Separate and inspect the mounting components.

INSTALLATION

1. Assemble mounting cushion assembly (8), spacers (4), retainer (9), and plate assembly (7). Bolt the components to bracket (14) using 65 foot-pounds torque on bolts (12). Secure bolts (12) with lock wires (13) through bolt heads and holes provided in bracket (14).
2. Position mounting assembly at crossmember and install bolts and washers (10) to attach mounting assembly to bracket (6) on engine. Tighten bolts (10) to 65 foot-pounds torque and secure with lock wire (11).
3. Lower the front of engine to allow weight to rest on mounting, then install bracket-to-crossmember bolts (1) and tighten to 75 foot-pounds torque.

NOTE: If bracket (6) on front of engine is replaced, tighten bracket bolts to 65 foot-pounds torque.



1 Bracket-to-Crossmember Bolts
2 Crossmember
3 Nut and Washer
4 Spacer
5 Bracket-to-Engine Bolts and Washers
6 Engine Mounting Bracket
7 Plate
8 Mounting Cushion Assembly
9 Cushion Retainer
10 Mounting-to-Bracket Bolts and Washers
11 Bolt Lock Wire
12 Bracket-to-Plate Bolt
13 Lock Wire
14 Bracket (at Crossmember)

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Figure 1—Engine Front Mounting on TV 70 Series (6V-53 Engine)

CONVENTIONAL MODELS (WITH 6V-53 ENGINE)

1. Referring to figure 2, remove bolts and washers which attach engine front mountings to frame crossmember and bracket on front of engine.
2. Raise front of engine far enough to permit removal of the two mountings, then remove mountings.
3. Place the new mountings in position shown in figure 2 (widest part toward engine bracket). Lower engine into place on mountings.
4. Install mounting bolts and washers and tighten bolts to torque values shown in "Engine Mounting Bolt Torque Chart."

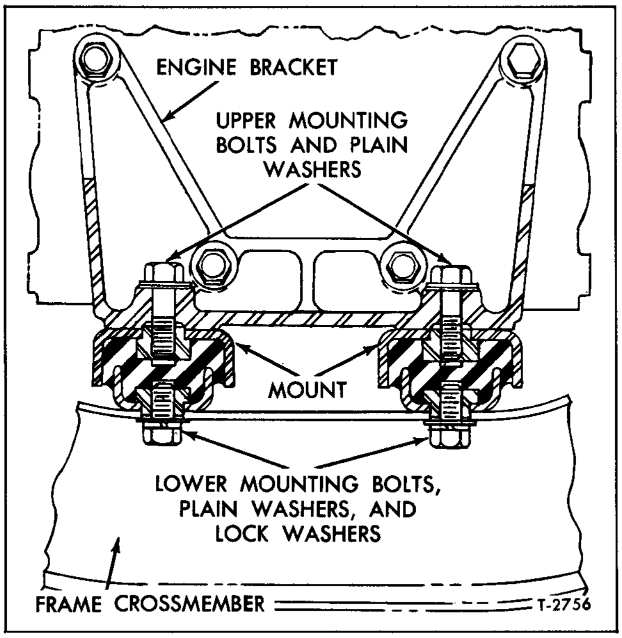
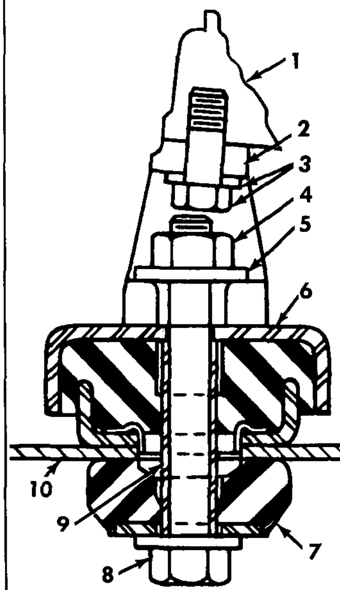


Figure 2—Engine Front Mounting on Conv. Cab Models (6V-53 Engine)



1 Engine Front Cover
2 Support
3 Bolts with Flat Washers
4 Mounting Bolt Nut
5 Flat Washer
6 Upper Mounting Assembly
7 Lower Cushion
8 Mounting Bolt with Flat Washer
9 Spacer
10 Frame Bracket or Crossmember

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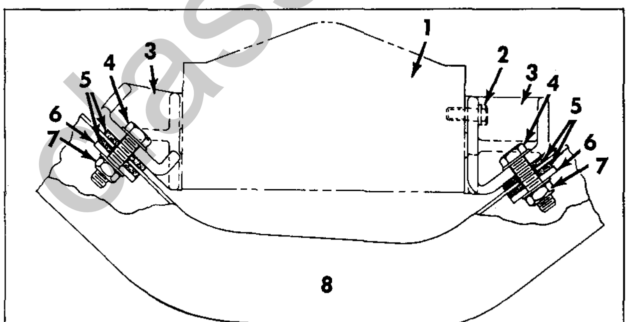
Figure 3—Engine Front Mounting on Conv. and Tilt Cab Models (V6 Gasoline Engine)

CONVENTIONAL AND TILT CAB MODELS (80 SERIES WITH V6 GASOLINE ENGINE)

NOTE: Key numbers in following text refer to figure 3.

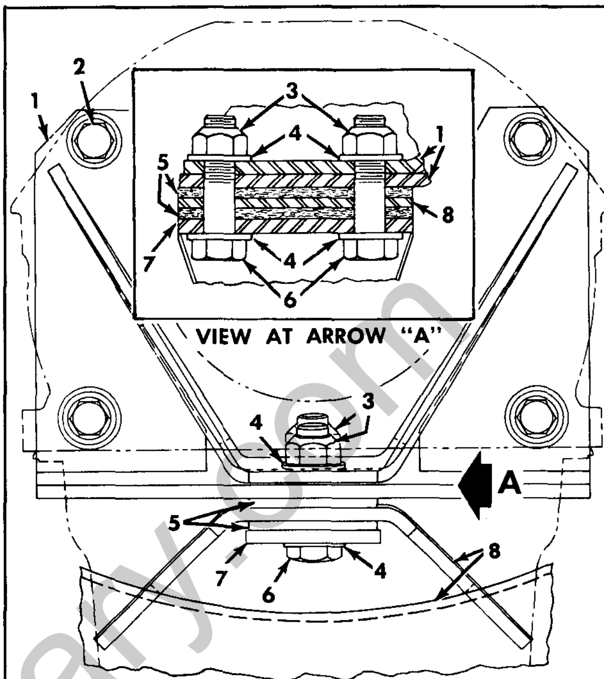
1. Disconnect lines and wiring as necessary to permit raising front of engine.
2. Remove nut and flat washer (4 and 5) from mounting bolt (8), then remove mounting bolt and lower cushion (7).
3. Raise front of engine high enough to permit removal of upper mounting assembly (6), then remove mounting assembly. If support (2) requires replacement, remove the two bolts and flat washers (3) attaching the support to engine cover (1).
4. Reverse the removal procedures previously given to install mounting parts. Tighten the support bolts and mounting bolt to torque values specified in "Engine Mounting Bolt Torque Chart."



1 Engine Cover	5 Cushion
2 Bolt and Flat Washer	6 Flat Washer
3 Bracket	7 Nut and Lock Washer
4 Bolt and Flat Washer	8 Front Crossmember

T-4147

Figure 4—Engine Front Mouting on Conv. Cab 90 Series (In-Line Diesel Engine)



1 Engine Bracket Assy. (Welded)	4 Plain Washers
2 Bolts with Plain Washers	5 Insulator
3 Mounting Bolt Nuts	6 Mounting Bolts
	7 Plate
	8 Frame Member

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Figure 5—Engine Front Mounting on Conv. Cab 90 Series (8V-71 Diesel Engine)

CONVENTIONAL CAB MODELS (90 SERIES WITH IN-LINE DIESEL ENGINE)

NOTE: Key numbers in following text refer to figure 4.

1. Remove front mounting bolts at both mountings, then raise front of engine high enough to permit removal of mounting cushions (5).
2. If mounting brackets (3) must be replaced, remove bolts and flat washers (2) and remove brackets.
3. Attach front mounting brackets (if removed) using bolts with flat washers (2).
4. Position mounting cushions (5) at crossmember (8) as shown, then insert mounting bolts

with flat washers (4) downward through bracket (3), cushions (5), and crossmember (8).

5. Lower the engine onto mountings, then install mounting bolt nut and lock washer (7) and tighten in accordance with "Engine Mounting Bolt Torque Chart."

CONVENTIONAL AND ALUM. TILT CAB MODELS (WITH 8V-71 ENGINE)

NOTE: Key numbers in following text refer to figure 5.

1. Remove mounting bolts (6), plate (7), and lower insulator (5), then raise front of engine high enough to permit removal of upper insulator (5).

2. Remove upper insulator and inspect engine bracket assembly (1).

3. If replacement of engine bracket (1) is required, remove bolts and washers (2) to detach bracket from engine.

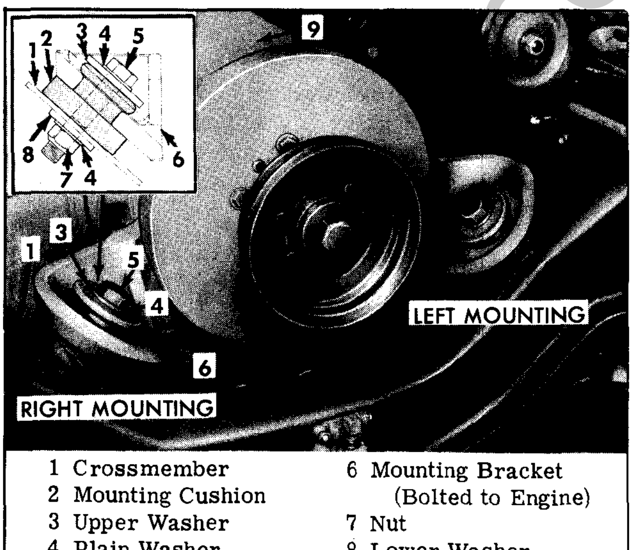
4. Reverse removal procedures given previously to install bracket (1) and/or insulators (5), referring to "Engine Mounting Bolt Torque Chart" for proper torque values for tightening bolts and nuts.

IN-LINE DIESEL ENGINE

DI AND FI-90 WITH AIR CONDITIONING

NOTE: Key numbers in following text refer to figure 6.

1. Remove nut and washers (7, 8, and 4) from both mounting bolts (5).



1 Crossmember	6 Mounting Bracket (Bolted to Engine)
2 Mounting Cushion	7 Nut
3 Upper Washer	8 Lower Washer
4 Plain Washer	9 Engine Front Cover
5 Mounting Bolt	

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Figure 6—Engine Front Mounting on DI, FI90 (Vehicles with Air Conditioning)

2. Refer to "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC 7B) of this manual, for information on transmission rear support on vehicles so equipped, and disconnect as necessary to allow rear end of transmission to move downward. Also loosen cap bolts at engine rear mountings (fig. 11).

3. Raise front end of engine to take weight off front mountings, then remove mounting parts.

4. If engine front mounting bracket (6) requires replacement, the pulley and damper must be removed first. When installing bracket, torque bolts to 85 foot-pounds, and torque damper hub retaining bolt to 300 foot-pounds.

5. Lubricate mounting cushions with special rubber lubricant, insert the cushions (2) through openings in bracket (6), then lower the front of engine so weight is on mounting cushions.

6. Install bolts and washers as shown in figure 8 and tighten mounting bolt nuts and rear mounting cap bolts to torques indicated on "Engine Mounting Bolt Torque Chart."

DI AND FI-90 (WITHOUT AIR CONDITIONING)

NOTE: Key numbers in following text refer to figure 7.

1. If support bracket (5) requires replacement, remove drive belts from crankshaft pulley, then remove six bolts attaching pulley to crankshaft and remove pulley.

2. Remove bolts attaching damper to flange on crankshaft hub, then remove damper.

3. Support front of engine and remove two bolts (8) which secure mountings (2) to support (5).

4. Raise front of engine to remove weight from support and provide clearance for removing mountings (2).

5. Remove bolts and washers (9 and 10) which attach support to crossmember (1), then remove support (5).

6. Turn mountings (2) counterclockwise to thread the mounting studs out of engine cover, and remove mountings (and shims (3), if used).

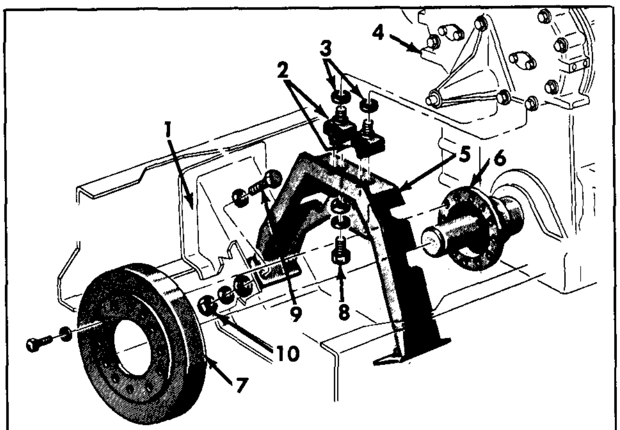
7. Reverse the removal procedure to install new mountings and/or support, referring to "Engine Mounting Bolt Torque Chart" for correct bolt torque.

NOTE: When installing front mountings (2), use shims (3) as required to assure that mounting studs are tight in engine cover when locating pins are aligned with locating holes in support (5).

ALUM. TILT SERIES WITH CUMMINS DIESEL ENGINE

NOTE: Key numbers in following text refer to figure 8.

1. Safely support front of engine, then remove



1 Frame Crossmember
2 Front Mounting
3 Shims (As Required)
4 Engine Cover
5 Front Support
6 Crankshaft Hub
7 Crankshaft Damper
8 Mounting Bolt and Washers
9 Support Bracket to Crossmember Bolt and Washers
10 Nut, Plain Washer, and Lock Washer

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Figure 7—Engine Front Mounting on DI, FI90 (Vehicles without Air Conditioning)

two support bolts which attach the upper support to lower support.

2. Raise front of engine to remove weight from support and provide clearance for removing collars and upper support.

3. If necessary, remove nuts and washers which attach lower support to crossmember. Remove bolts, washers, then remove support.

4. Reverse the removal procedure to install new collars and/or supports.

NOTE: When installing supports make sure identification letter is facing forward on both supports (fig. 8).

Refer to "Engine Mounting Bolt Torque Chart" for correct bolt and nut torques.

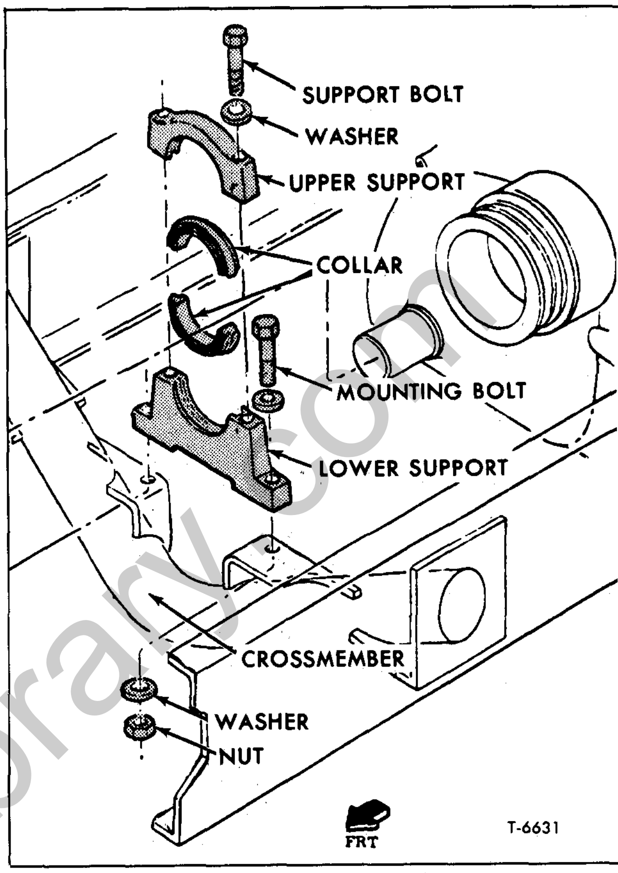


Figure 8—Engine Front Mounting Components on Alum. Tilt Series with Cummins Diesel Engine

ENGINE REAR MOUNTING REPLACEMENT

TV 70 MODELS

Refer to figure 9 for engine rear mounting.

1. Remove upper bolts from both rear mountings, then raise rear of power plant sufficiently to permit removal of mountings.

NOTE: If necessary, remove any wiring, piping, or accessories which would be damaged by raising engine.

2. Remove lower mounting bolts, and remove mountings and spacers (TV70 only).

3. If engine bracket requires replacement, remove bolts and washers attaching brackets to engine flywheel housing, then remove brackets.

4. Reverse the removal procedures to install brackets and/or mounting and tighten bolts to torque valves shown on "Engine Mounting Bolt Torque Chart."

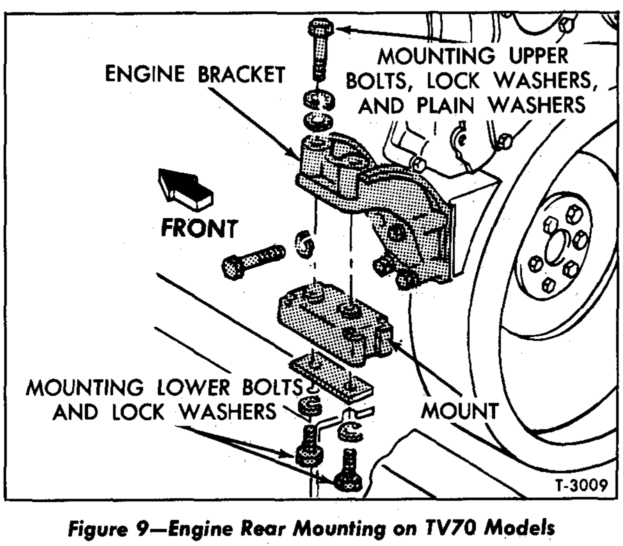


Figure 9—Engine Rear Mounting on TV70 Models

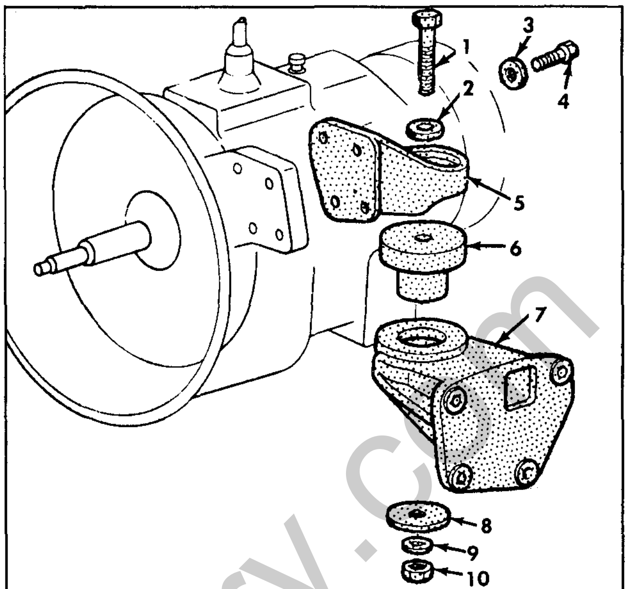
HV, JV70 MODELS

NOTE: Key numbers in following text refer to figure 10.

1. Remove nut and washers (8, 9, and 10) from mounting bolt at each rear mounting, then raise rear of engine high enough to permit removal of mounting cushion (6).
2. Remove bolt and special washer (1 and 2), then remove mounting cushion assembly.
3. If brackets (5 and 7) require replacement remove attaching bolts and remove brackets.
4. Reverse removal procedures to install brackets and mounting cushions.

NOTE: When assembling mounting cushions, lubricate the cushion surfaces with special lubricant before installing.

5. Tighten bracket bolts and mounting bolts to torque values given in "Engine Mounting Bolt Torque Chart."



1 Mounting Bolt
2 Special Washer
3 Special Washer
4 Bracket to Engine Bolt
5 Engine Mounting Bracket
6 Mounting Cushion
7 Frame Bracket
8 Special Washer
9 Special Washer
10 Nut

T-4568

Figure 10—Engine Rear Mounting on HV, JV70 Models

ALL VEHICLES WITH TRUNNION TYPE MOUNTINGS

NOTE: Key numbers in following text refer to figure 11.

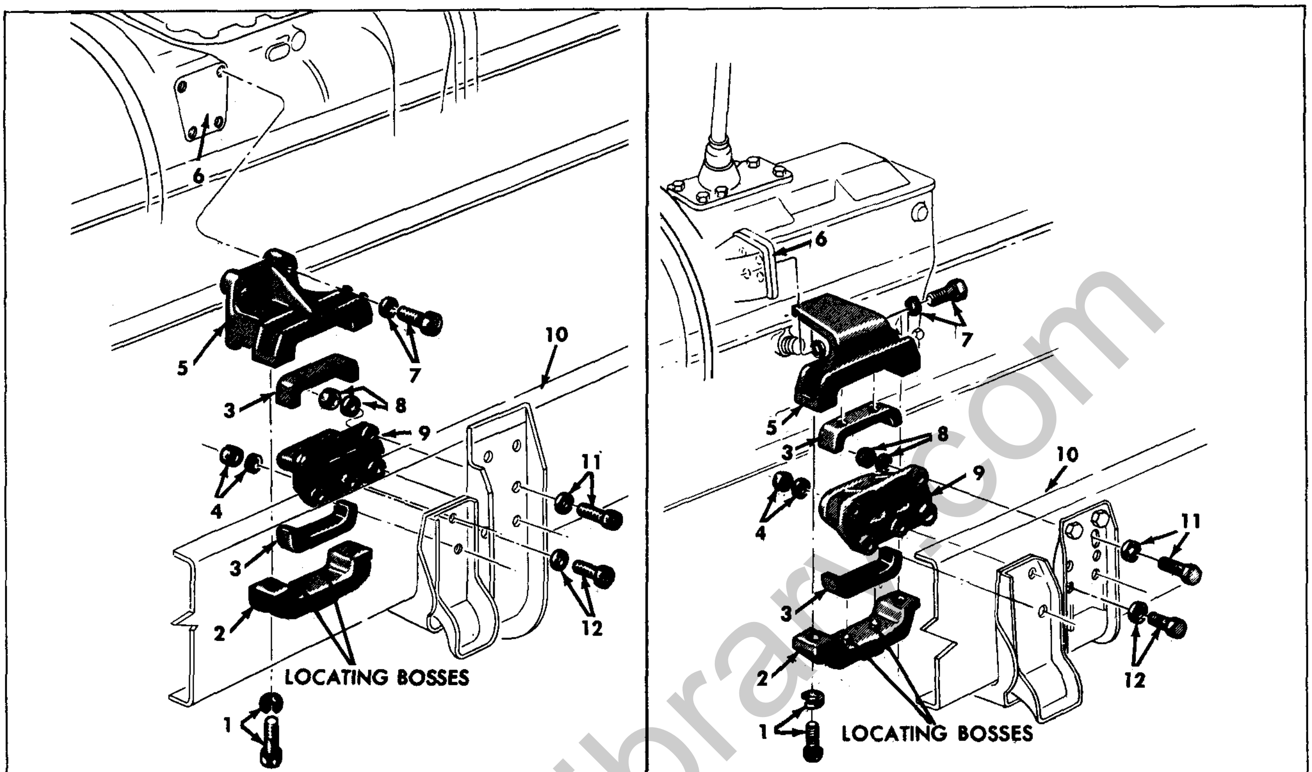
NOTE: If a mounting is used at rear of transmission, it will be necessary to disconnect attaching parts to permit rear of transmission to be raised for engine rear mounting replacement. Refer to applicable portion of "TRANSMISSION-ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B) in this manual for necessary information to disconnect transmission rear support and to assemble the components to provide correct load after replacing engine rear mounting.

1. Remove caps (2), and lower cushions (3) from mounting brackets (5).
2. With transmission rear support (if used) disconnected, raise rear end of power plant using care to prevent tipping.

CAUTION: Raise rear of power plant only high enough to permit removal of upper cushion; and provide safety blocking to prevent tipping and possible damage to front mountings.

3. Remove upper cushion (3) and if necessary remove mounting brackets.
4. Reverse the removal procedure to install mounting brackets and/or cushions.
5. Tighten all bolts to torque values shown on "Engine Mounting Bolt Torque Chart."

If vehicle has transmission rear mounting, assemble parts and adjust as instructed in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" in TRANSMISSIONS AND CLUTCHES (SEC. 7) of this manual.



VIEW A—TYPICAL REAR MOUNTING WITH FULLER TRANS. | VIEW B—TYPICAL REAR MOUNTING WITH SPICER TRANS.

1 Cap Bolt and Washer
2 Mounting Bracket Cap
3 Mounting Cushions
4 Nut and Washer
5 Bracket (at Trans.)
6 Mounting Pad (on Trans.)
7 Bracket Bolt and Washer
8 Nut and Washer
9 Frame Bracket
10 Frame Side Rail
11 Frame Bracket Bolt (Large)
12 Frame Bracket Bolt (Small)

T-6201

Figure 11—Trunnion Type Engine Rear Mountings (Typical)

Inspect engine front and rear mountings as part of regular engine maintenance program. Be sure to keep bolts and nuts tightened to torque values specified on chart.

SECTION 6K

ENGINE COOLING SYSTEM

Contents of this section are listed in Index below:

Cooling system in all models is of the pressure-type. A pressure relief valve, either separate or integral with the radiator or surge tank filler cap, maintains a specific pressure in cooling system.

NOTE: For cooling system information related to Cummins Engine, that is not covered in this manual, refer to appropriate Cummins Service publication.

COOLANT CIRCULATION

V6 GASOLINE ENGINES (Fig. 1)

The water pump, belt-driven from engine crankshaft pulley, circulates the coolant through the cooling system. The coolant from radiator (and surge tank - when used) is forced into front of each cylinder bank where it traverses around the cylinders to rear of each bank. From here it flows upward through transfer holes and into rear of cylinder heads, then back to front of heads. At this point a portion of coolant flows up and out of the engine water manifold and back to radiator. The remaining portion of coolant is recirculated back into water pump and engine.

Two thermostats are used in V6 gasoline engines. Thermostats are installed in top of engine water manifold.

Engine Warm-Up Period

During engine warm-up period, the thermostat valves are closed and shut off circulation to the radiator. As the engine warms up, the valves open slowly, allowing a gradually increasing amount of liquid to flow through cooling system, until engine reaches normal operating temperature.

During engine warm-up, coolant is recirculated back through by-pass at side of water manifold and into engine to assist in warm-up of engine.

As engine water temperature reaches normal, thermostat valves become fully open. The valves then may move frequently to regulate flow of coolant into radiator. Thus an efficient operating temperature is maintained. A temperature gauge on dash is connected to a thermal unit in engine cylinder head water outlet manifold.

6V-53 DIESEL ENGINE (Fig. 2)

Coolant is drawn from lower portion of the radiator by a belt-driven water pump and discharged through engine oil cooler passages to cylinder block. From cylinder block, coolant flows up through cylinder heads and forward to thermostat housing at front of each cylinder head. If engine is at operating temperature, coolant flows through thermostat housing to upper portion of radiator. If engine is below operating temperature, coolant is returned to suction side of water pump

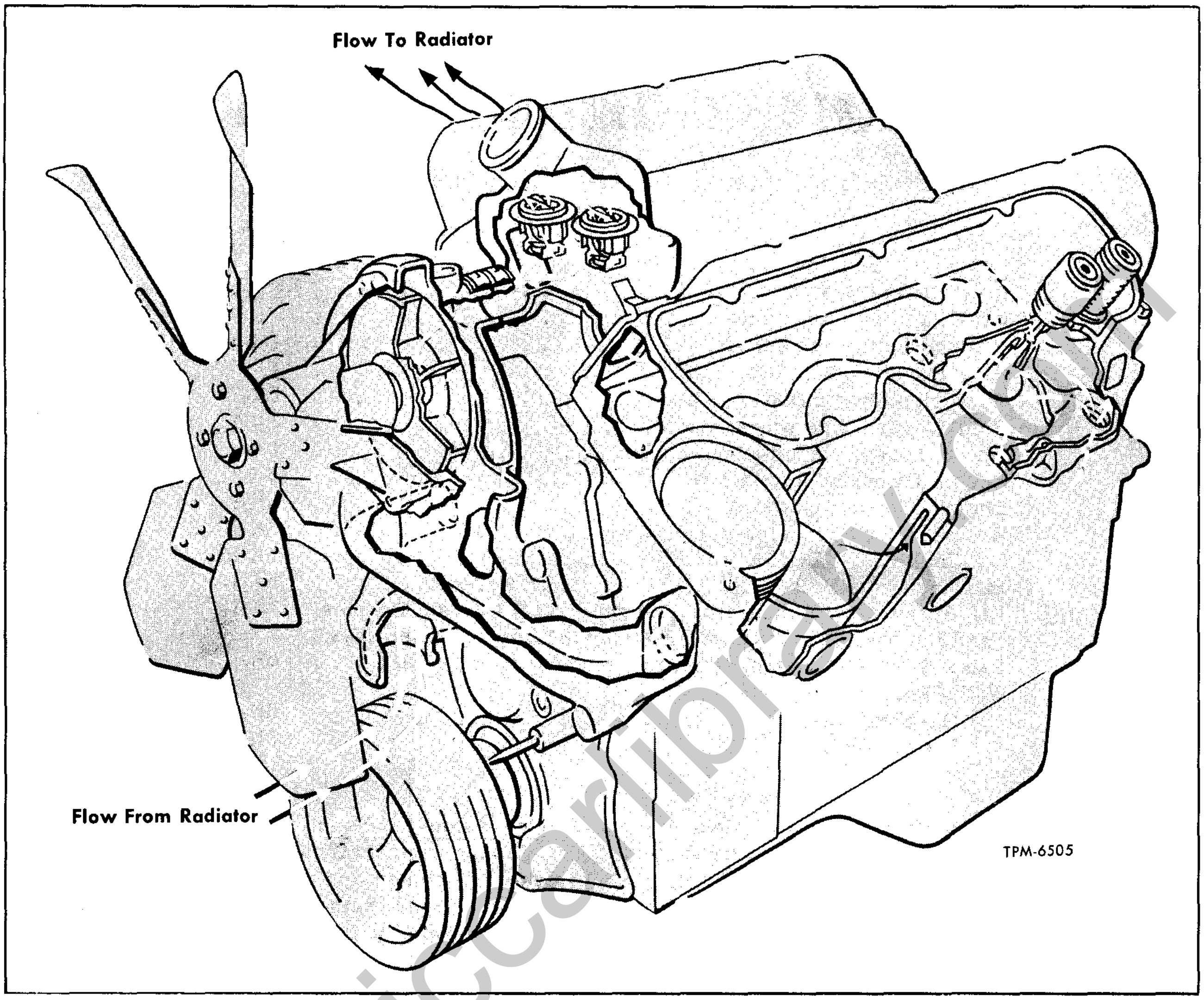


Figure 1—Coolant Circulation (V6 Gasoline Engine)

through a by-pass system. Two thermostats control engine operating temperature by regulating the volume of coolant flow through the radiator core.

Engine Warm-up Period

During the engine warm-up period, thermostats direct coolant back to suction side of water pump. Coolant is recirculated within the engine to shorten engine warm-up period. As engine reaches operating temperature, thermostats begin to open. As thermostats open, a gradual increasing volume of coolant flows through radiator, while a gradual decreasing volume flows through the by-pass system. Thermostats regulate flow to maintain an operating temperature within the specified limits.

6-71N DIESEL ENGINES (Refer to Fig. 3)

Coolant is circulated by means of a centrifugal pump driven from the blower. Pump draws coolant through radiator and oil cooler, discharging it into lower part of cylinder block (fig. 3). Openings in water jackets around cylinder bores connect with corresponding openings in cylinder head, circulating liquid around exhaust valves and fuel injectors.

A water manifold, bolted to cylinder head, discharges coolant into radiator where it is cooled.

Control of engine temperature is accomplished by means of a thermostat directing the flow of cooling liquid within a sealed cooling system. A sealed system utilizes a pressure valve either separate or integral with filler cap, which maintains a slight pressure within the system when engine is running at normal operating temperature, thus raising the efficiency of the system. On some models, a surge tank permits expansion of cooling liquid without loss from the system.

Engine Warm-Up Period

During engine warm-up period, action of thermostat closes off the flow of cooling liquid into

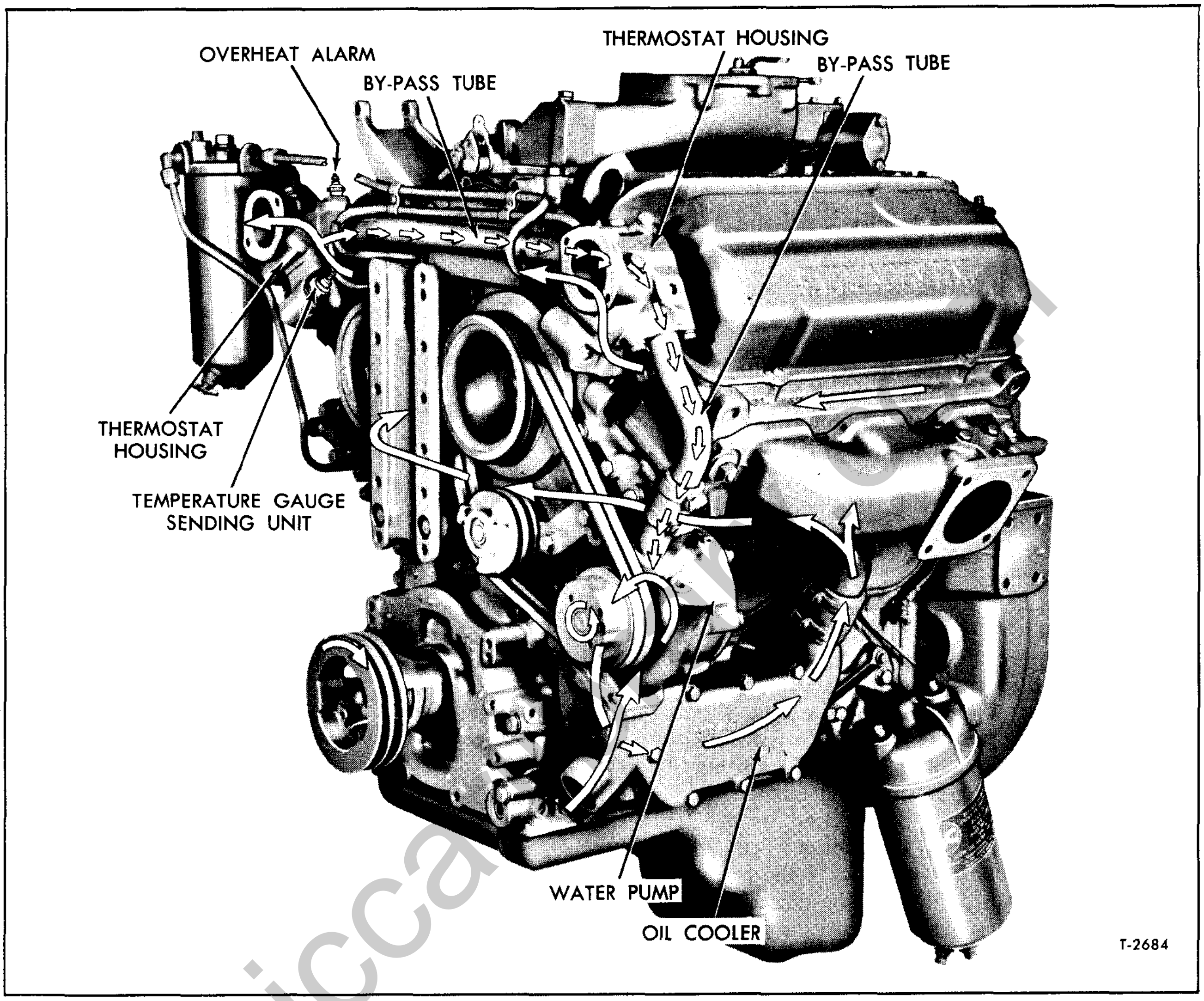


Figure 2—Coolant Circulation (6V-53 Diesel Engine)

radiator, directing the coolant flow through a by-pass tube. This arrangement permits circulation of liquid within the engine, warming the engine and shortening the warm-up period. As engine reaches normal operating temperature, thermostat valve opens gradually, allowing cooling liquid to flow through radiator, thus maintaining an efficient operating temperature.

8V-71 DIESEL ENGINES (Refer to Fig. 4)

Coolant is drawn from the lower portion of the radiator by the water pump and is forced through the oil cooler housing and into cylinder block (fig. 4). From the cylinder block the coolant passes up through the cylinder head and, when the engine is at normal operating temperature, through the thermostat housing and into the upper portion of the radiator. Then the coolant passes down a series of tubes, where the coolant temperature is lowered by the air stream created by the revolving fan.

Control of engine temperature is accomplished by means of two thermostats controlling the flow of cooling liquid within a sealed cooling system. A sealed system utilizes a pressure valve either separate or integral with filler cap, which maintains a slight pressure within the system when engine is running at normal operating temperature, thus raising the efficiency of the system.

Engine Warm-up Period

During the engine warm-up period, the action of the thermostats directs the flow of cooling liquid back to the water pump. This arrangement permits the circulation of liquid within the engine, warming the engine and shortening the warm-up period. As the engine reaches normal operating temperature, the thermostats open gradually, allowing hot liquid to flow through the radiator, where it is again cooled to maintain proper operating temperature.

INSPECTION OF SYSTEM

Although action of the cooling system controls the operating temperature of the engine, improper ignition timing (gasoline engines) or improper or insufficient lubricating oil in the engine crankcase may cause the engine to overheat, even though the cooling system is functioning properly. These items should also be checked for cause of improper cooling.

Cooling systems must be kept air-tight. As the pressure in the system raises the boiling point of the coolant, any air leak would lower boiling point and result in loss of coolant. Check radiator cap seal and all radiator connections. Entire cooling system can be checked for leaks in castings, connection hoses, gaskets, pressure valves, and filler cap using a conventional cooling system testing kit which can usually be obtained locally.

CAUTION: When the engine is at normal operating temperature or above, the internal pressure built up in the cooling system will blow out scalding fluid and vapors if the radiator cap is suddenly removed. To prevent loss of coolant and to avoid the danger of being burned, the coolant level should be checked, or coolant added, only when the engine is cool. If the cap must be removed when the engine is hot, place a cloth over the cap and rotate the cap slowly counterclockwise to first stop and allow pressure to escape completely. Then turn cap again slowly counterclockwise to remove.

DRAINING COOLING SYSTEM

1. Remove radiator filler cap.
2. Remove plug or open drain cock at bottom of radiator core.
3. Open petcock or remove drain plug at each side of cylinder block.

a. On models with 6-71N engines, open drain cocks at bottom of thermostat housing (if equipped), water pump, oil cooler, and cylinder block at rear of blower below fuel pump (fig. 5).

b. On all 8V engine models, open drain cock at each side of engine cylinder block (Lower Views, fig. 6). At right side of engine, open drain cock at bottom of engine oil cooler (Upper Right View, fig. 6).

4. If tilt cab model, place heater temperature control in "HEAT" position.
5. Remove drain plug from bottom of engine oil cooler (if equipped).

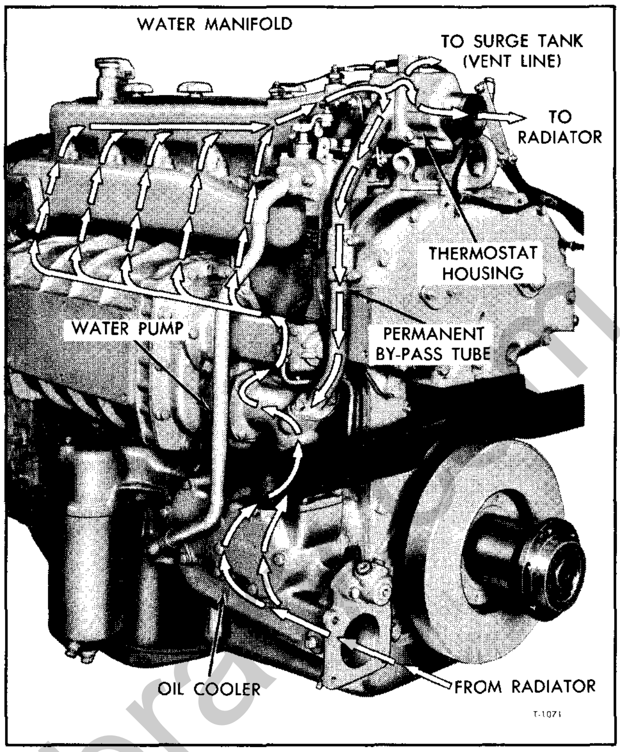


Figure 3—Coolant Circulation (6-71 Diesel Engine)

6. Remove drain plug from bottom of cooling system filter assembly (if equipped).
7. If vehicle is equipped with a water-cooled air compressor, disconnect air compressor coolant hose from side of cylinder block.

FILLING COOLING SYSTEM

When cold water is poured into the radiator, the thermostats will close even though the engine is warm. This action may trap air in cylinder block and head passages. The trapped air will leak through the thermostat vents thereby lowering the water level.

Use The Following Method When Filling System:

1. If vehicle is equipped with heater, the control valve (tilt cab models) must be wide open before filling cooling system. This operation is to prevent air from being trapped in heater and lines.
2. When checking level of coolant, remove radiator cap SLOWLY (if engine is hot). No additional water is required if water is visible in filler neck or at bottom of filler tube.
3. Fill radiator until water can be seen through filler neck or to bottom of filler tube.
4. Add more water slowly until no more air bubbles can be seen. Run engine a few minutes to further expel air, then add more liquid if necessary to bring it up to proper level.

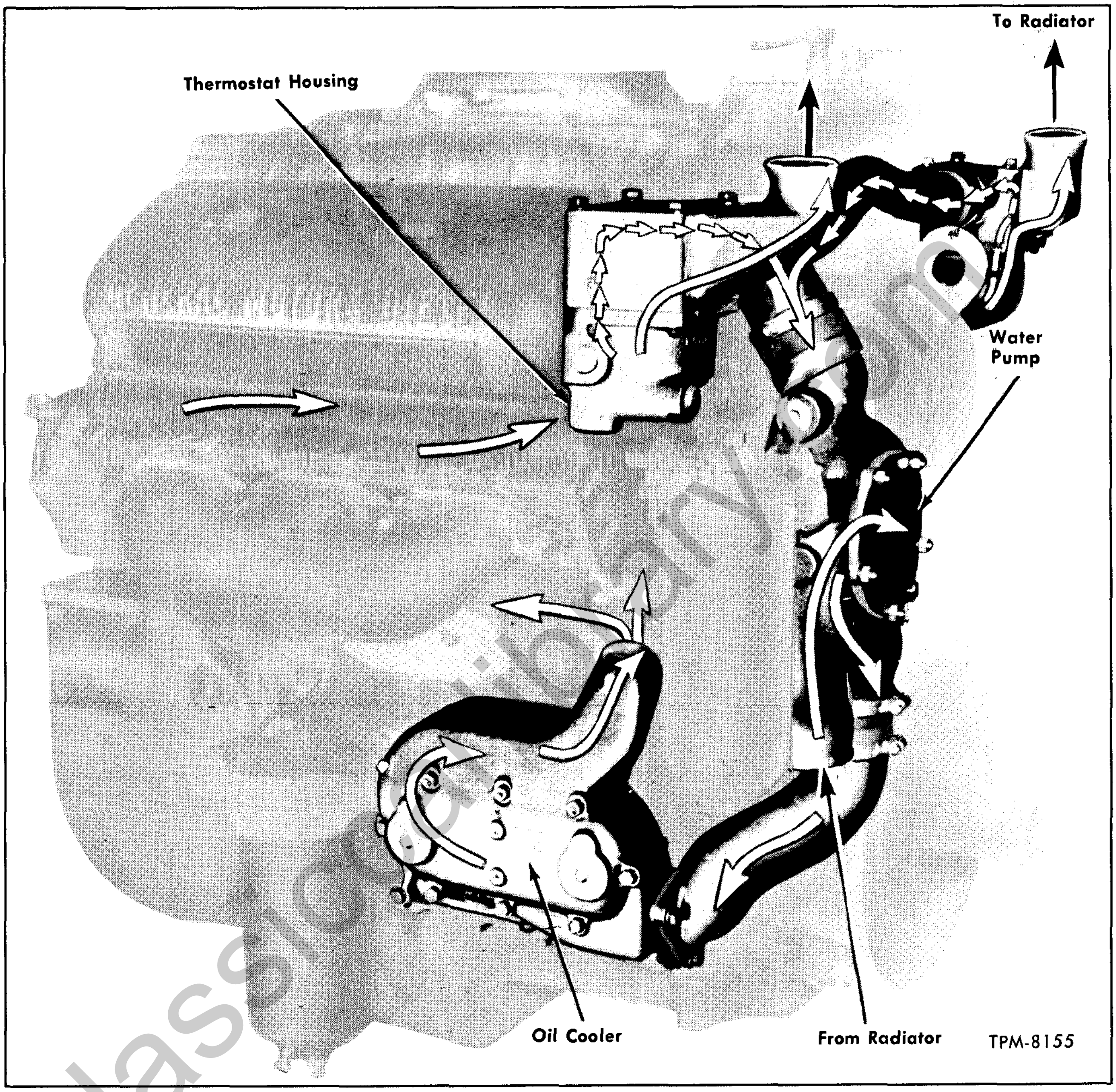


Figure 4—Coolant Circulation (8V-71 Diesel Engine)

5. If vehicle is equipped with a water-cooled air compressor, vent air from compressor cooling cavities and connecting lines by loosening small hex plug at high side of compressor.

6. Do not overfill if anti-freeze solution is used.

CAUTION: DO NOT POUR COLD WATER IN RADIATOR WHILE ENGINE IS HOT. Wait until boiling ceases, then add water slowly while engine is idling. Install radiator cap firmly.

CLEANING SYSTEM

Unless water in cooling system is treated with a corrosion preventive, rust and scale may eventually clog water passages in radiator and water jackets. This condition is aggravated in some localities by the formation of insoluble salts from water used.

Cleaning solutions, commercially available, will successfully clean cooling systems of rust, scale, sludge, and grease when used as directed by the manufacturers. However, if radiator is

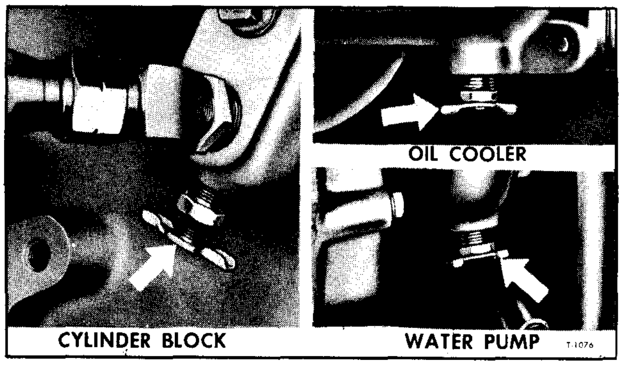


Figure 5—Cylinder Block, Oil Cooler, and Water Pump Drain Points (6-71 Diesel Engine)

clogged with insoluble scale formations, reliable radiator service stations in the various localities are best equipped to remove such formations.

GM Cooling System Cleaner or other commercial cleaning solutions are especially effective in removing rust, scale, and corrosion from the radiator and engine water passages. Use cleaner only as directed on label. Particularly at winter check-up, preferably before and after using anti-freeze solutions, radiator and entire system should be cleaned with a recommended cleaning solution as follows:

CLEANING

1. Drain system, then close cocks and install drain plugs.

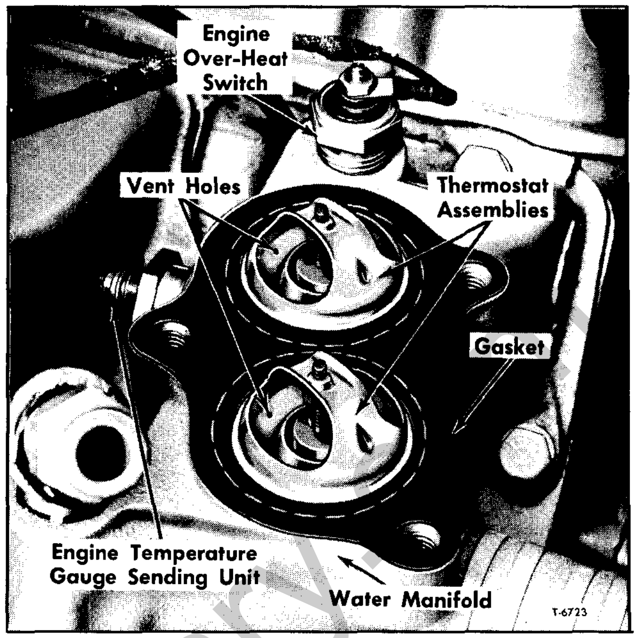


Figure 7—Engine Units for Overheat Switch and Temperature Gauge (V6 Gasoline Engine) (Typical)

2. Fill system with cleaning solution. Always follow manufacturer's directions.

3. With radiator covered and radiator cap on tight, run engine 15 to 20 minutes at fast idle speed Drain system completely.

4. If cleaning solution used requires a neutralizer, use as directed by manufacturer.

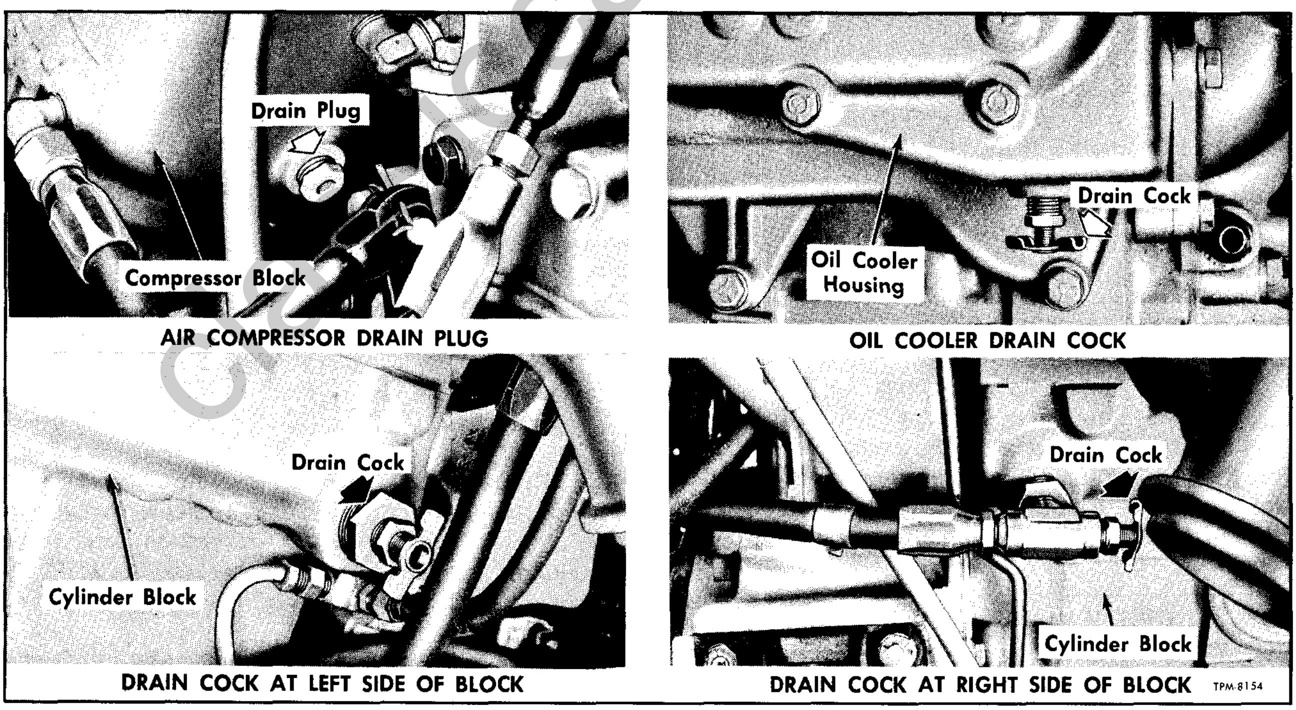


Figure 6—Drain Points on 8V-71 Diesel Engine (Typical)

FLUSHING

Before pressure flushing system, tighten cylinder head bolts to prevent possible water leaks into cylinders and crankcase and remove thermostats. When pressure flushing, apply air gradually, as radiator will stand only a limited pressure.

CORROSION PREVENTION

Use of water containing lime, alkali, and other impurities is a major cause of rust and scale formation in cooling system. Air or exhaust gas leaking into the system can also be cause of rust and corrosion. A rust preventive, inhibitor, or water filter should be used continuously.

Drain and flush cooling system every 24 months and add new anti-freeze solution.

INHIBITORS AND SEALERS

In general, inhibitors are not cleaners and will not remove scale and rust already formed. GM Cooling System Inhibitor and Sealer will retard rust and scale formation and is compatible with aluminum components. Inhibitor and sealer should be used immediately after new anti-freeze solution has been added to system and every fall thereafter.

It is important not to use too much inhibitor or to use two different types at the same time.

NOTE: USE INHIBITOR AND SEALER ONLY AS INSTRUCTED ON LABEL.

AIR SUCTION TEST

Air may be drawn into system due to low liquid level in the radiator or surge tank, leaky water pump, or loose hose connections. This action will also cause corrosion.

1. Replace radiator cap having integral pressure relief valve with a plain filler cap less the relief valve.

2. If a separate pressure relief valve is used, remove valve and install pressure valve opening cover. Make sure gasket is in good condition.

3. Make sure radiator cap seal is in good condition and will make an air-tight seal. Adjust level of cooling liquid in radiator, allowing ample room for expansion to avoid any overflow loss during test.

4. Attach a length of rubber tube to lower end of overflow tube. This connection must be air-tight. Run engine with transmission in neutral at a safe speed until temperature gauge stops rising and remains stationary.

5. Without changing engine speed, put end of rubber tube in a bottle of water, avoiding kinks and sharp bends that might block flow of air. Watch for bubbles in bottle of water. The continuous appearance of bubbles indicates that air is being sucked into the cooling system.

6. Correct condition by tightening hose clamps and fitting connections. Also, examine all hoses carefully and if cracked, swollen, or deteriorated in any way, replace with new hose.

EXHAUST GAS LEAKAGE TEST

Exhaust gas may be blown into the cooling system past cylinder head gasket or through cracks in the cylinder head and block. This action will also cause corrosion and possible damage to engine combustion chamber components.

1. Start test with engine cold. Remove drive belt to prevent water pump operation.

2. Partially drain cooling system until cooling liquid level is at top of thermostat well. Remove thermostat(s) and add coolant until level is at top of thermostat well.

3. With transmission in neutral, start engine and accelerate it several times.

4. Watch for bubbles in water or smoke at surface of coolant while accelerating engine. Also watch when engine speed drops back to idle. The appearance of bubbles or a sudden rise of cooling liquid indicates exhaust gas leakage into cooling system. Make test quickly before boiling starts as steam bubbles will give misleading results.

5. If exhaust gas leakage is evident, replace cylinder head gasket or gaskets, then test again. Tighten cylinder head bolts to torque specified in GASOLINE ENGINES (SEC. 6A) of this manual. If leaks are still evident, cylinder head or block may be cracked. Correct cause of leakage, then install thermostats and adjust drive belt. Fill cooling system.

COLD WEATHER OPERATION

Water, with an inhibitor, can be safely used as a cooling medium in climates where temperatures do not reach below 32°F. In lower temperatures, anti-freeze solutions must be used. Before installing anti-freeze solution, cooling system should be inspected and serviced for cold weather operation, as previously described under "Cleaning System."

Cylinder head bolts should be checked for tightness and gasket replaced if necessary, to avoid possibility of anti-freeze solution leaking into engine, and exhaust gases entering cooling system. If Ethylene Glycol anti-freeze is to be used on vehicles having a water filter, the water filter must be serviced at regular intervals as directed later in this section under "Water Filter." After anti-freeze solution has been installed, entire system should be inspected regularly for leaks.

THAWING COOLING SYSTEM

If cooling medium in system becomes frozen solid, place vehicle in warm place until ice is completely thawed out. UNDER NO CIRCUMSTANCES SHOULD ENGINE BE RUN WHEN COOLING SYSTEM IS FROZEN SOLID.

The inhibited year-around (permanent-type) engine coolant, used to fill the cooling system at the factory is a high quality solution that meets General Motors Specification 1899-M. This factory-fill coolant solution is formulated to withstand two full calendar years of normal operation without draining or adding inhibitors, and provides freezing protection to -20°F.

It is the owner's responsibility to keep the freeze protection at a level commensurate with the area in which the vehicle will be operated. Regardless of climate, system protection should be maintained at least to 0°F., to provide adequate corrosion protection. When adding solution due to loss of coolant for any reason, or in areas where temperatures lower than -20°F., may occur, a sufficient amount of an ethylene glycol base coolant that meets GM Specification 1899-M should be used.

Every two years the cooling system should be serviced by flushing with plain water, then completely refilling with a fresh solution of water and a high-quality, inhibited (permanent type) glycol base coolant meeting GM Specification 1899-M, and providing freezing protection at least to read 0°F. At this time, also add GM Cooling System Inhibitor and Sealer or equivalent. In addition, Cooling System Inhibitor and Sealer should be added every fall thereafter. GM Cooling System Inhibitor retards the formation of rust or scale and is compatible with aluminum components.

IMPORTANT: Alcohol or methanol base coolants or plain water are not recommended for your truck at any time.

WATER TEMPERATURE INDICATOR

Electric type temperature gauge system consists of an engine thermal plug electrically connected with registering gauge mounted on instrument panel. Refer to applicable wiring diagram in "Wiring Diagram" booklet. System is activated when ignition is turned on.

Engine unit is installed in engine water manifold on V6 gasoline engines (fig. 7) and in thermostat housing on 6V-53 diesel engines (fig. 2).

The engine unit is mounted in engine water manifold on 6-71 Diesel engine (fig. 8), or in thermostat housing on 8V-71 Diesel engines (fig. 9). Engine water temperature, acting on element in thermal plug, causes variation of resistance in electrical circuit.

WATER TEMPERATURE INDICATOR TEST

1. Disconnect wire at engine unit.

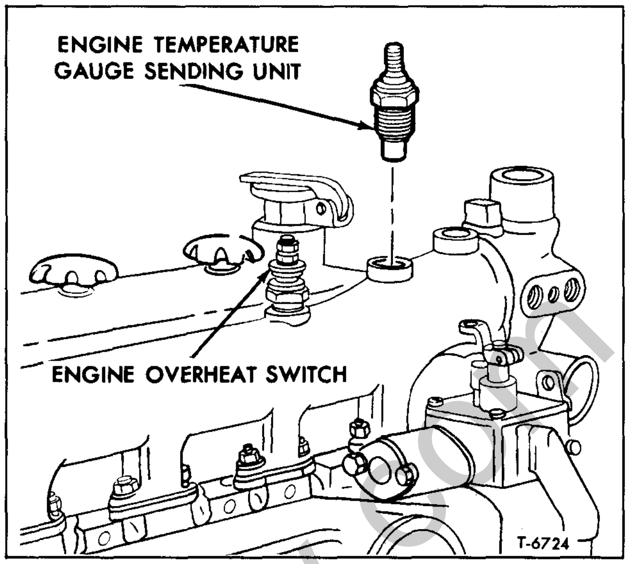


Figure 8—Temperature Gauge Sending Unit and Engine Overheat Switch (6-71 Diesel Engine)

2. Connect a test light consisting of a 12-volt, 2-candlepower bulb and a pair of test leads in circuit by clipping one lead to battery positive terminal and other lead to body of engine gauge unit. If bulb lights, unit is properly grounded. If bulb does not light, check for presence of sealing compound around threads of unit. Remove compound and repeat test. Make sure unit is properly grounded before proceeding with next test.

3. Remove test lead from body of unit and connect lead to terminal of unit. If bulb lights, engine unit is internally short-circuited and should be replaced.

4. Remove test light and reinstall wire on unit.

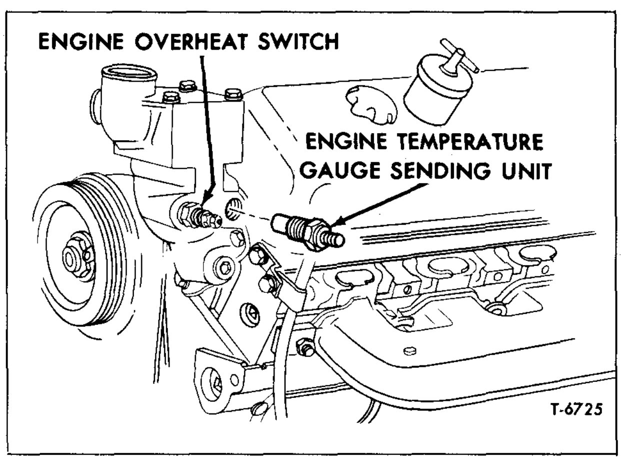


Figure 9—Temperature Gauge Sending Unit and Engine Overheat Switch (8V-71 Diesel Engine)

5. If engine unit tests satisfactory under the previous conditions, check the following items according to nature of difficulty:

a. If gauge does not register when ignition or control switch is turned on: This may be caused by a break in the circuit between the gauge and the switch or a short between this lead and ground.

b. If gauge shows high temperature under all conditions, wire leading from gauge to engine unit is shorted to ground.

c. If gauge registers a low temperature under all conditions, wire between gauge and engine unit is broken.

Do not attempt to repair either the engine unit or the gauge. When installing new engine unit, do not use thread compound on unit threads, as this will increase electrical resistance of unit and cause faulty reading on gauge.

ENGINE OVERHEAT ALARM

Overheat alarm switch is located near the engine unit of water temperature indicator. Refer to figures 2, 7, 8, 9, and 10 for appropriate location of engine overheat alarm.

NOTE: Electrical wire ends of overheat switch and of temperature indicator are retained by hex nut and may be easily confused with each other.

The body of the overheat switch is made of brass, while the body of the temperature gauge sending unit is zinc plated.

The alarm system is interconnected to a tell-tale light and, on some vehicles, to a buzzer. The purpose of this system is to signal the driver when engine temperature exceeds a safe range. Refer to appropriate wiring diagram in applicable "Wiring Diagrams" manual for alarm system circuit. Overheat temperature switch is not repairable and must be replaced as an assembly or unit.

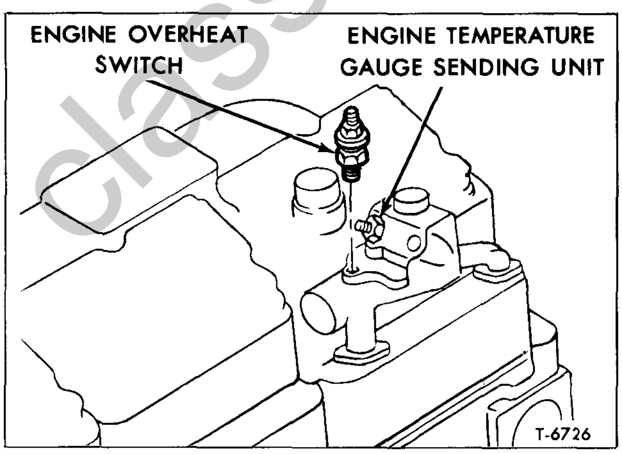


Figure 10—Temperature Gauge Sending Unit and Engine Overheat Switch (Cummins Diesel Engine)

TESTING ENGINE UNIT AND CIRCUIT

NOTE: Before testing engine unit, make the following circuit tests:

Circuit Tests

1. Disconnect wire at engine unit.
2. Connect a test light consisting of a 2-candle-power 12-volt bulb and a pair of test leads in circuit by clipping one lead to a hot terminal and other lead to body of engine unit. If bulb does not light, check for presence of sealing compound, oil or paint around threads of unit. Remove insulating substance and repeat test. Make sure unit is properly grounded before proceeding with tests.
3. Remove test lead from body of engine unit and connect lead to terminal of unit. Then providing engine water temperature is not exceeding switch setting, and the bulb lights, engine unit is internally short-circuited and should be replaced. Refer to "Specifications" for switch setting.
4. Remove test light and reinstall wire on engine unit.
5. If alarm buzzer sounds and/or tell-tale lights under all conditions with engine control switch in "ON" position, wire leading from buzzer or light to engine unit is shorted to ground.
6. With engine control switch in "ON" position, and light does not come on when terminal at temperature switch is shorted to ground, a break or short in wire between engine unit and engine control switch is indicated.
7. When installing engine unit, do not use thread compound on unit threads, as this will increase electrical resistance and cause faulty reaction.

Testing Switch Contacts

NOTE: Switch unit must be removed from engine manifold in order to make this test. Before testing unit, be sure that entire unit is pre-heated to approximately engine temperature.

Insert unit tube and lower half of body threads in hydraulic oil, heated to a temperature 15° F. to 20°F., higher than unit point contact setting listed in "Specifications." Agitate oil thoroughly (and gently tap unit). If points contact readily, correct working of instrument is indicated.

ENGINE THERMOSTATS

Two thermostats are installed in engine water outlet manifold on all V6 gasoline engines (fig. 7). The 6V-53 Diesel engines have two thermostats installed in thermostat housings at front of each cylinder head (fig. 2).

A thermostat consisting of a barrel-type sleeve and stem assembly (fig. 11) is used on 6-71 Diesel engine.

Two thermostats are used in 8V-71 Diesel engines, one in each thermostat housing (fig. 12).

Thermostat as used on Diesel engines, consists of barrel-type sleeve and stem assembly which when activated by thermo element travels vertically to contact seat in the engine thermostat cover. In this open position, coolant is directed to radiator core instead of back to water pump.

Thermostats consist of a restriction valve controlled by a thermostatic element. Restriction valve cracks or just starts to open at predetermined temperature and continues to open as engine coolant temperature increases. Refer to "Coolant Circulation" earlier in this section for operation of engine thermostats.

NOTE: To assure proper cooling and engine warm-up it is very important that the correct thermostat be used. Refer to "Specifications" at end of this section for correct thermostat application.

THERMOSTAT CHECK

If it is suspected that thermostat is not functioning properly, remove thermostat assembly. If the thermostat appears to be in good condition, the following test should be conducted.

Suspend thermostat and thermometer in water with thermometer located close to thermostat. Thermostat must be completely submerged and water thoroughly agitated while heating. Apply heat to the water and record both the temperature at which the thermostat begins to open and the temperature at which the thermostat is fully open.

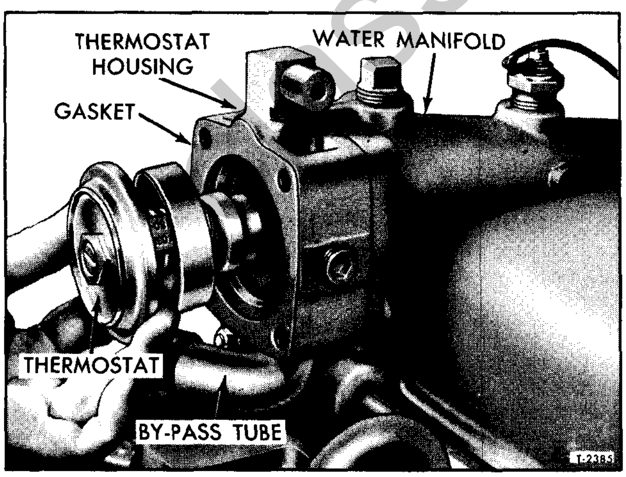


Figure 11—Installing Thermostat (6-71 Diesel Engine)

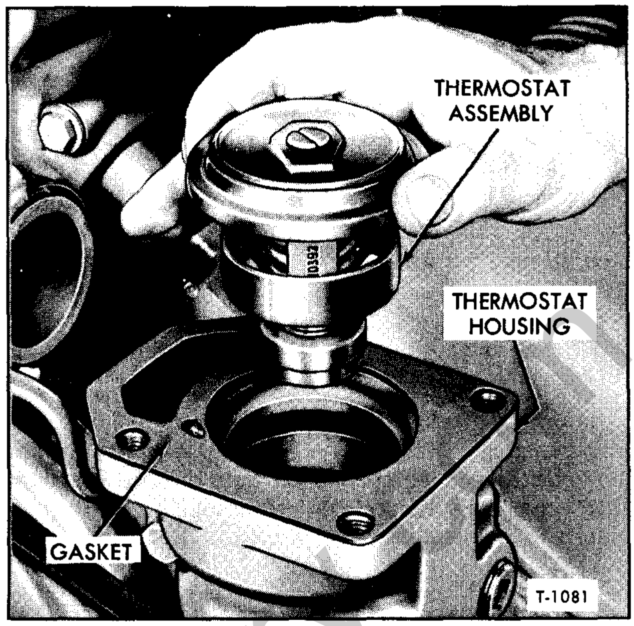


Figure 12—Replacing Thermostat (Typical for 8V-71 Diesel Engine)

Compare temperature readings taken in the test with those given under "Thermostats" in "Specifications" at end of this section.

Do not attempt to repair thermostat. If thermostat does not function properly, replace with new unit which has been checked as directed above.

Use new gasket when installing thermostat. Fill cooling system, then run engine until normal operating temperature is reached. Check for coolant leakage at thermostat cover gasket.

WATER FILTER

Water filter (figs. 13 and 14) installed on some vehicles is used to filter and condition water in cooling system. The filter element should be initially changed after 2500 to 3000 miles. After initial change, the filter should be serviced periodically 7500 to 10,000 miles or 300 to 500 hours depending upon engine workload, conditions, etc.

Water filter installation on 90 tilt cab models has been modified to simplify the replacement of filter element. Gate valves are provided at top and bottom of filter to shut off and prevent loss of coolant, while changing filter.

ELEMENT REPLACEMENT

NOTE: Key numbers in text refer to figure 15.

1. Close gate valves at top and bottom of filter on Alum tilt cab models. On remaining models,

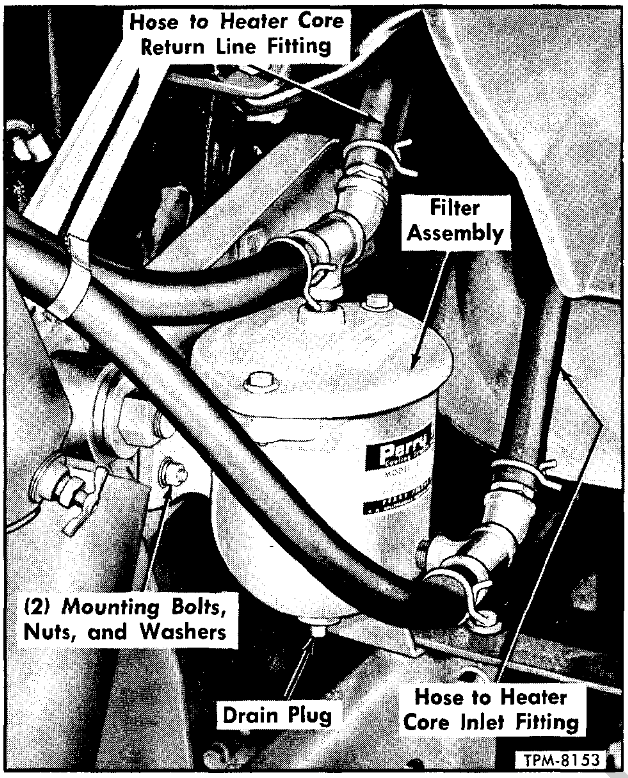


Figure 13—Water Filter Installed (Typical—All Models Except Alum. Tilt Cab)

clamp off filter supply and return hose. Care should be taken that hose is not cracked or otherwise damaged.

2. Remove drain plug (9) from lower side of filter.

3. Remove two bolts (1) which attach cover (2) to filter. Remove cover and gasket (3). Discard gasket.

4. Remove upper plate (4), element (5), lower plate (6), and spring (7), from filter body (8). Flush out filter body.

5. Discard filter element, then clean all parts. Examine element lower plate for excessive corrosion. Deep pits in the plate do not warrant replacement. Clean plate by wire brushing. This plate generates current for the electrochemical action of filter element. If excessively corroded, replace.

6. Referring to figure 15, position spring (7), lower plate (6), new element (5), and upper plate (4) in filger body (8). Install cover (2) using new gasket (3). Tighten cover attaching bolts evenly and firmly. Install drain plug (9) in bottom of filter body.

7. Open gate valves at top and bottom of filter or release hose clamps. Start and operate engine until water in cooling system is warm. Check for air lock in filter. If cover of filter becomes warm no air-lock condition exists in system. If cover remains cool, vent system same as for a hot water heater system.

8. Refill system to proper level.

OIL COOLER

Refer to current applicable Detroit Diesel Manual for information on oil coolers used on Detroit Diesel engines. The following information

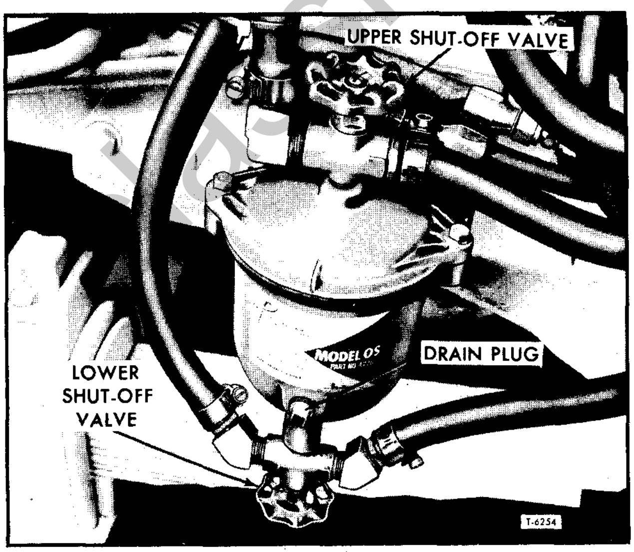
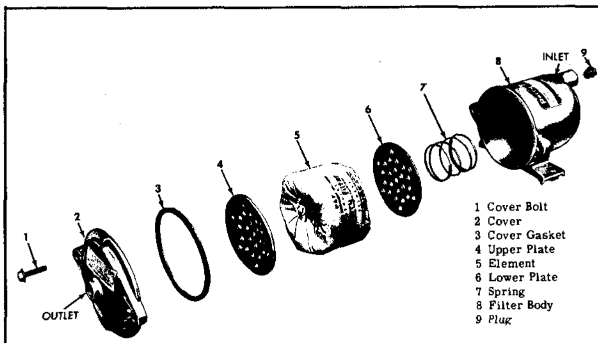


Figure 14—Water Filter Installed Alum. Tilt Cab Models)



1 Cover Bolt	6 Lower Plate
2 Cover	7 Spring
3 Cover Gasket	8 Filler Body
4 Upper Plate	9 Plug
5 Element	

Figure 15—Water Filter Components

pertains to all other engines using oil cooler.

Models equipped with oil cooler use the type of oil cooling system shown in figure 16. Oil is filtered, circulated through oil cooler, and returned to engine.

If engine difficulties are encountered and there is suspicion that foreign matter has entered the oil cooler, the oil cooler and connecting lines must be flushed before engine is put back into operation.

Oil cooler, located at bottom of radiator core, should be flushed in the following manner:

1. Disconnect oil cooler lines at oil filter.
2. Back-flush oil cooler and lines using clean solvent and compressed air. DO NOT EXCEED 100 PSI AIR PRESSURE.
3. Remove all remaining cleaning solvent from the system with compressed air.
4. Flush system again with the same type of oil normally circulated through the cooler.
5. Test flow of oil through cooler. If flow is not restricted, reconnect oil cooler lines. If flow is restricted, have oil cooler element replaced by a radiator specialist.

FAN AND DRIVE BELTS

DRIVE BELT TENSION ADJUSTMENT

Drive belts must be kept at proper tension. A loose or broken drive belt will affect operation of driven accessory. A drive belt that is too tight will place excessive stress on the bearings within the driven accessory.

V-Belt Tension

Fan belt tension on vehicles equipped with V-belts should be adjusted to 120-130 pounds on new belts, using (J-23573) belt tension gauge. Used drive belts should be adjusted to 80-90 pounds. Gauge should be placed at the center of the greatest span.

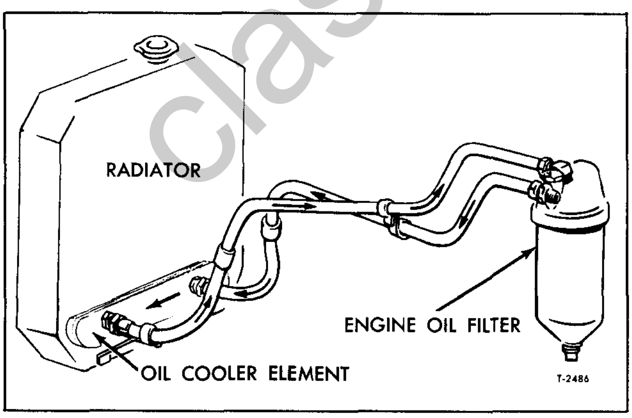


Figure 16—Oil Cooler Circuit (All Engines Except Detroit Diesel)

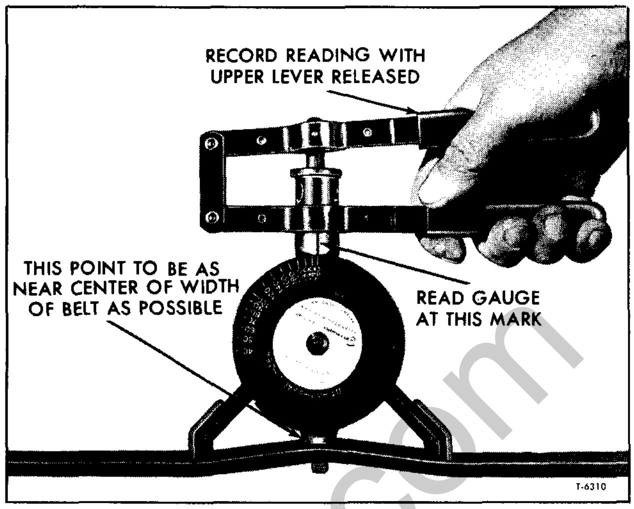


Figure 17—Using Poly-V Belt Tension Gauge

Poly-V Belt Tension

Fan belt tension on vehicles equipped with Poly-V belts should be adjusted using (J-23586) belt tension gauge, as shown in figure 17. Gauge should be placed at center of longest belt span to obtain proper reading. When adjusting a new drive belt, adjust tension to "NEW" belt specification, turn engine over several times, then reset belt tension to "NEW" belt specification.

NOTE: A Poly-V belt is considered USED after 1-hour's operation or approximately 50 miles driving time.

Poly-V belt tension specifications are as follows:

DI, FI 90		
Power Steering Pump	- New	103# - 113#
	- Used	78# - 88#
Generator	- New	44# - 54#
	- Used	29# - 39#
Air Conditioning Compressor	- New	84# - 94#
	- Used	64# 74#
Fan Drive	- New	255# - 265#
	- Used	235# - 245#
DH, FH 90		
Generator	- New	84# - 94#
	- Used	64# - 74#

DRIVE BELT REPLACEMENT

On some vehicles, several accessories may be driven from multiple groove crankshaft pulley, and the replacement of any one inside drive belt will make it necessary to remove all the outside belts first.

NOTE: Instructions for replacing power steering drive belt are given in "POWER STEERING"

(SEC. 9B) of this manual. Refer to AIR COMPRESSOR AND GOVERNOR (SEC. 6T) of this manual for adjustment and replacement instructions for air compressor drive belts.

IMPORTANT: When replacing dual or triple drive belts, it is essential that entire set be replaced at same time. Belts are available in matched sets only.

Gas Engines

1. Remove the air compressor drive belt (if equipped).
2. Loosen bolt at generator adjusting arm and loosen two pivot bolts at generator support bracket.
3. Move generator toward engine until belts can be removed from pulley.
4. To install new belts, position belts on pulleys and move accessory away from engine until a tension of 120 to 130 pounds is measured.
5. Tighten accessory adjusting arm bolt and pivot bolts.
6. Install air compressor drive belt (if equipped).

6V-53 Diesel Engines (Fan Drive Belts) (Refer to Fig. 18)

1. Loosen four adjusting bracket locking bolts.
2. Turn adjusting bolt to loosen drive belts. Remove drive belts.
3. Install new belts on pulleys and turn adjusting bolt to tighten belts. Adjust belt tension to 120 to 130 pounds tension as described earlier in this section.
4. Tighten adjusting bracket bolts to 40 to 50 foot-pounds torque.

6V-53 Diesel Engines (Water Pump Drive Belts) (Refer to Fig. 18)

1. Loosen drive belt adjusting arm pivot bolt and adjusting bolt and move adjusting arm to loosen drive belts. Remove drive belts.
2. Install new drive belts on pulleys.
3. Move adjusting arm to tighten belts. Adjust belt tension to 120 to 130 pounds tension.
4. Tighten pivot bolt and adjusting bolt firmly.

6-71, 8V-71 Diesel Engines

1. Loosen drive belt adjusting arm pivot bolt and adjusting bolt and move adjusting arm to loosen drive belts. Remove drive belt(s).
2. Install new drive belt(s) on pulleys.
3. Move adjusting arm to tighten belt(s). Adjust belt tension as described earlier in this section.
4. Tighten pivot bolt and adjusting bolt firmly.

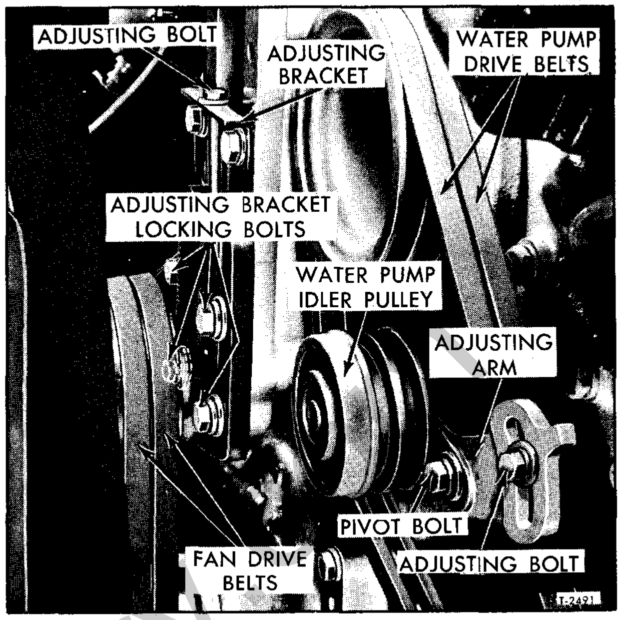


Figure 18—Belt Adjusting Mechanism (6V-53 Engine)

FAN SUPPORT AND ADUSTMENT ASSEMBLY (6V-53 DIESEL ENGINES)

Fan is bolted to pulley of fan support assembly. Fan drive belts are adjusted at the adjusting bracket shown in figure 18. Bearings of fan support assembly are lubricated at assembly.

REMOVAL (Refer to Fig. 18)

1. Remove six fan bolts and remove fan. Loosen fan drive belts and remove belts from fan pulley.
2. Remove adjusting bolt from the adjusting bracket.
3. Remove four adjusting bracket bolts and remove support and adjustment assembly from engine.

DISASSEMBLY (Refer to Fig. 19)

1. Tap fan hub cap from pulley. Remove bolt and washer, then lift pulley assembly from fan shaft. Remove front bearing assembly, shims and bearing spacer.

NOTE: Exercise caution when removing shims. Also note the number of shims removed.

2. To remove seal and rear bearing assembly, reach through the front of pulley and tap around bearing cup to drive bearing assembly and seal toward rear of pulley.
3. Remove front bearing cup in same manner by tapping bearing cup toward front of pulley.

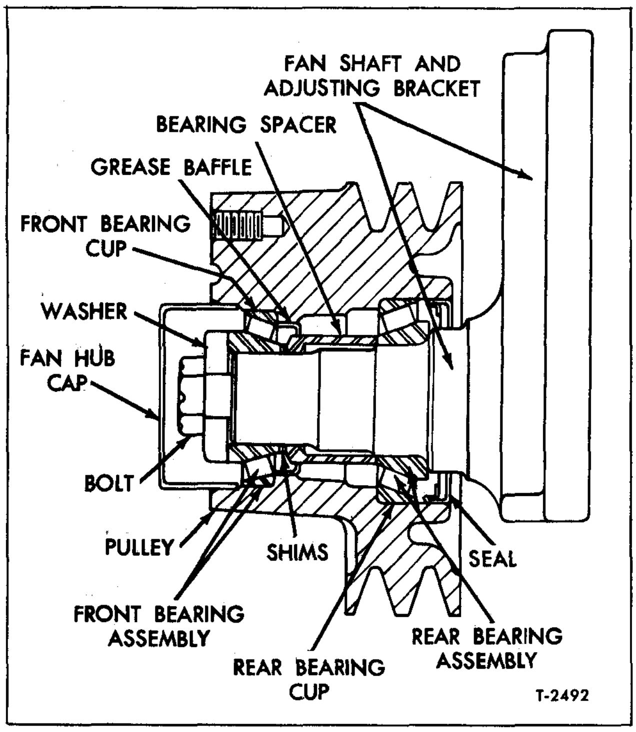


Figure 19—Separately Mounted Fan Support Assembly (6V-53 Engine)

4. Using a suitable size sleeve, drive grease baffle toward rear of pulley.

ASSEMBLY (Refer to Fig. 19)

1. Clean all parts in solvent and wipe dry. Check bearings for damage, wear and roughness. Replace bearing if found defective in any way.
2. Using a suitable size sleeve, tap bearing cups and grease baffle into position in pulley.
3. Use grade No. 2 lithium base, multi-purpose grease and pressure lubricate bearings. Fill fan hub cap to ¾ full. Take half of grease from hub cap and pack into cavity between grease baffle and rear bearing cup. Refill hub cap to 3/4 full.
4. Insert rear bearing assembly into position in pulley and tap seal into place in pulley.
5. Install pulley on shaft and insert bearing spacer into pulley. Position shims against bearing spacer and install front bearing assembly.

NOTE: Three different size shims are available and the thickness of each is identified by notches on the shim as follows:

No notches	- 0.015 inch
1 notch	- 0.020 inch
2 notches	- 0.025 inch

6. Install flat washer and bolt. While rotating pulley, tighten bolt to 85 to 95 foot-pounds torque.
7. Check end play of pulley with dial indicator. End play must be between 0.001 and 0.006 inch.
8. If end play is not correct, remove bolt, washer and front bearing assembly. Arrange shims to give correct end play (identify shims as noted in Step 5).
9. Install front bearing assembly and repeat Steps 6 and 7. After proper end play is obtained, tap fan hub cap into position on pulley.

INSTALLATION

1. Place support and adjustment assembly in its original position on the engine.
2. Start four adjusting bracket locking bolts.
3. Install drive belts on pulley and install adjusting bolt in adjusting bracket.
4. Adjust belt tension as described previously in this section.

FAN, FAN SHAFT, AND SUPPORT ASSEMBLY (SERIES 71 ENGINES)

Fan support assemblies shown in figures 20 and 21 are used on 6-71 and 8V-71 engines in conventional cab models.

Fan drive belt tension adjustments are made at the accessories that are driven in conjunction with the fan.

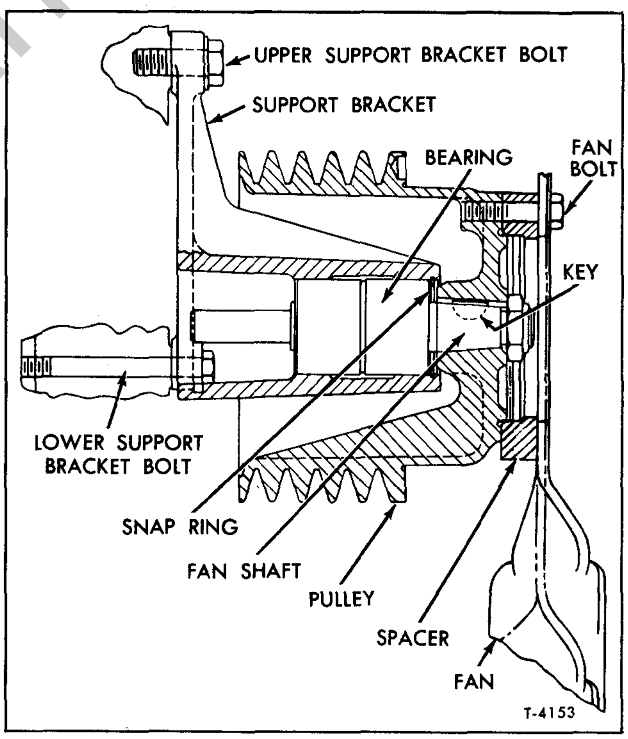


Figure 20—Separately Mounted Fan Support Assembly (6-71 Engine) (Typical)

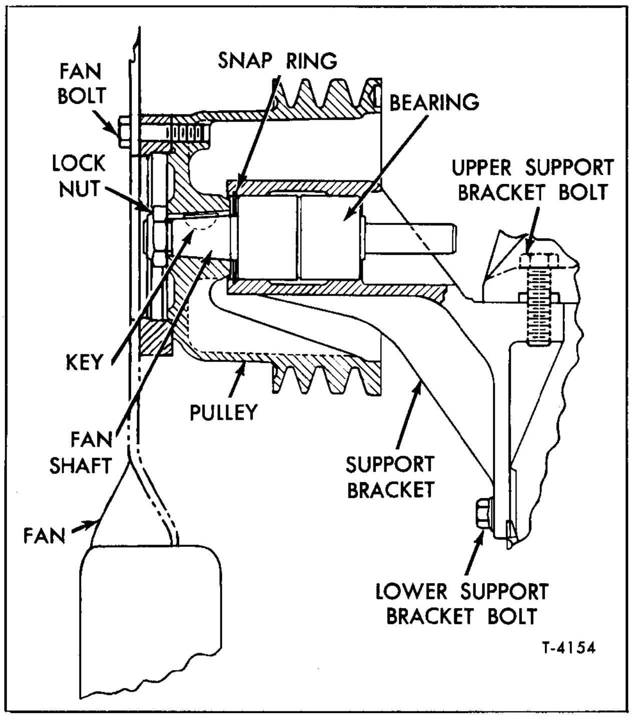


Figure 21 —Separately Mounted Fan Support Assembly (8V-71 Engine) (Typical)

Fan shaft and bearing assembly must be replaced as a unit. Bearing is sealed and does not require periodic lubrication.

FAN SHAFT AND BEARING REPLACEMENT

Removal

1. Remove six fan attaching bolts and remove fan.
2. Loosen fan drive belts and remove belts from fan pulley.
3. On 6-71 engine, remove upper support bracket bolt and loosen two lower support bracket bolts. Lift support bracket upward and remove entire support assembly from engine.
4. On 8V-71 engine, remove three support bracket bolts and remove support assembly.
5. Remove pulley retaining nut from fan shaft. Use a puller to remove pulley from shaft. Remove key.
6. Remove snap ring from support bracket at tapered end of fan shaft.
7. Using an arbor press, remove fan shaft and bearing assembly from support bracket.

IMPORTANT: Do not immerse bearing in solvent or clean with solvent, since lubricant will be affected, rendering bearing unfit for further service.

8. Clean all parts (except bearing) in solvent and wipe dry.

Installation

1. Press new fan shaft and bearing assembly into support bracket by applying force to outer race with arbor press.
2. Assemble snap ring, key, fan pulley, and pulley retaining nut on fan shaft. Tighten nut to 90 to 100 foot-pounds torque.
3. On 6-71 engine, install support bracket on engine. Install upper bolt and tighten to 60 to 70 foot-pounds torque on conventional cab models, and 85 to 105 foot-pounds torque on tilt cab models. Tighten lower bolts to 30 to 35 foot-pounds torque on conventional cab models and 25 to 30 foot-pounds torque on tilt cab models.
4. On 8V-71 engine, install support bracket on engine and retain with three bolts. Tighten upper bolt to 90-110 foot-pounds torque. Tighten lower bolts to 35-45 foot-pounds torque.
5. Position drive belts on fan pulley and adjust belt tension as described previously.
6. Install fan and retain with six bolts. Tighten bolts to 25 to 30 foot-pounds torque.

FAN DRIVE HUB ASSEMBLY (TILT CAB MODELS)

V6 GASOLINE ENGINES

V6 Gasoline engines in tilt cab models employ the type of fan drive shown in figure 22. The pulley hub on these engines is also used as a vibration damper. The pulley hub is secured to front of en-

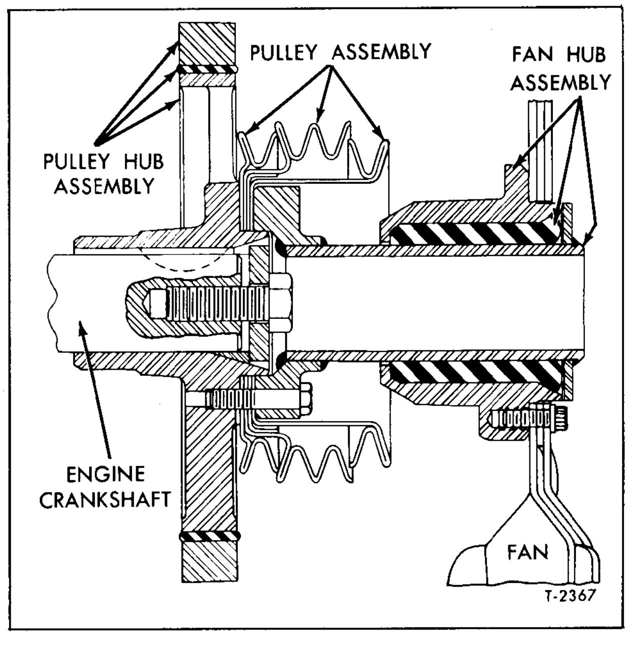


Figure 22 —Fan Drive Hub Assembly (Typical For V6 Gasoline Engines in Tilt Cab Models)

gine crankshaft by a single bolt. Fan hub assembly is fastened to the pulley hub by six equally spaced bolts. Fan blade assembly is mounted on front of fan hub assembly and secured by six special bolts.

Fan Drive Hub Removal (Refer to Fig. 22)

1. Remove six bolts attaching fan blade assembly to fan hub and remove fan blade assembly.
2. Remove six bolts which secure fan hub to pulley hub and remove fan hub. Remove pulleys if desired.

Fan Drive Hub Installation

1. Position pulleys (if removed) on pulley hub.
2. Install fan hub and retain with six bolts. Tighten bolts to 15 to 20 foot-pounds torque.
3. Install fan blade and secure with six special bolts. Tighten bolts evenly to 20 to 25 foot-pounds torque.

WATER PUMPS

GASOLINE ENGINES

Water pumps are mounted in the engine front cover casting which serves as a housing for the pump impeller and is cored with water pump by-passages.

WATER PUMP REMOVAL

NOTE: The water pumps have a removable pulley mounted on a flanged hub.

1. Remove mounting bolts and washers.
2. Remove water pump assembly and gasket from engine front cover.
3. Discard used gasket in all cases.

WATER PUMP OVERHAUL
(401M, 478M ENGINES)

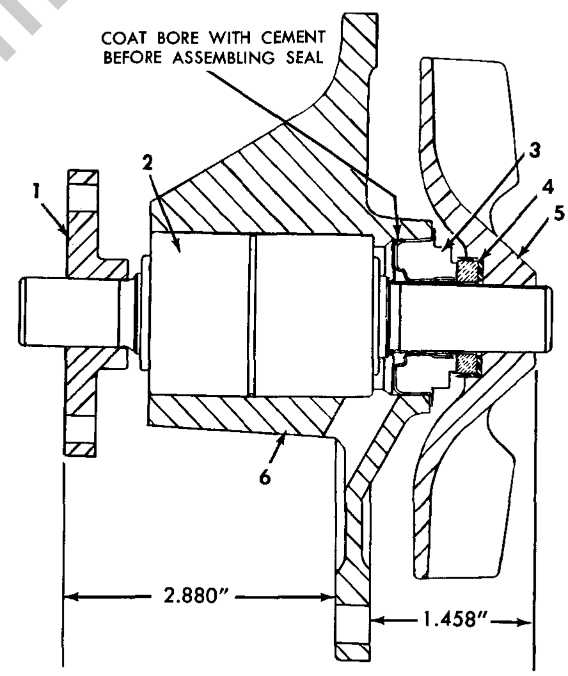
NOTE: Key numbers in text refer to figure 23 except as otherwise indicated.

Disassembly

1. Support hub (1) on press and press the shaft out of hub.
2. Insert spacers between impeller (5) and pump body (6) to support impeller while pressing shaft and bearing assembly (2) out of impeller and pump body. Support body on press bed, then with arbor press and suitable driver, press on impeller end of shaft and remove shaft and bearing assembly (2).
3. Drive seal (3) out of pump body. If seal seat (4) in impeller is not in good condition, use a thin blade to pry the seal seat out of impeller. Thoroughly clean the impeller counterbore.
4. Clean and inspect water pump components. In case defective parts are found, a repair kit consisting of shaft and bearing assembly, seal, and gasket is available.

Assembly (Fig. 23)

1. Be sure seal cavity of pump body (6) is completely cleaned. Any remaining old cement could result in a coolant leak between pump body and seal assembly (3).
2. Apply sealer in seal cavity in body, then press new seal assembly (3) squarely into place with seal flange seated against body.
3. Support pump body (6) solidly on press bed, then press on shaft bearing outer housing to install shaft and bearing assembly in body. Bearing housing must bottom in pump body.
4. Place neoprene seal on ceramic seat (4), then install seat in the recess in impeller with neoprene seal bottomed in counterbore.
5. Support front end of pump shaft and press impeller onto rear end of shaft.



1 Pulley Hub
2 Shaft and Bearing Assembly
3 Seal Assembly
4 Seal Seat
5 Impeller
6 Water Pump Body
T-7060

Figure 23—Engine Water Pump (401M and 478M Engines)

a. On pump used on 401M and 478M engines, the impeller (5) must be positioned so rear face of impeller hub is 1.458" from mounting flange surface on pump body (fig. 23).

6. While supporting rear end of pump shaft, press pulley hub on front end of shaft to dimensions shown in figure 23. Note that on pumps for 401M and 478M engines (fig. 27) the extended side of hub (1) is toward bearing.

WATER PUMP INSTALLATION

1. Reverse the "Removal" procedure explained previously using new gasket. Tighten attaching bolts evenly and firmly.

2. Close all drains and fill the cooling system.

3. Start the engine and check for leaks.

DIESEL ENGINES

6V-53 ENGINE WATER PUMP

A centrifugal-type water pump, as shown in figure 24, is mounted on top of the engine oil cooler housing, as shown in figure 25. The pump is belt-driven by one of the camshafts. An impeller is pressed onto one end of the water pump shaft and the water pump drive pulley is pressed onto the opposite end. The pump shaft is supported on a sealed, double-row combination radial and thrust ball bearing. Coolant is prevented from moving along the shaft toward the bearing by a seal. The shaft and bearing constitute an assembly, and are serviced as such, since the shaft serves as an inner race of the ball bearing.

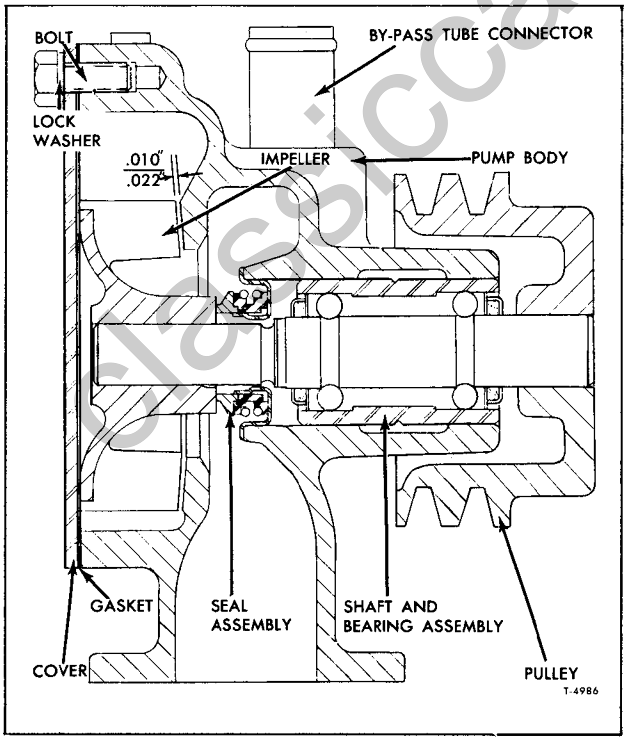


Figure 24—Water Pump Assembly (6V-53 Engine)

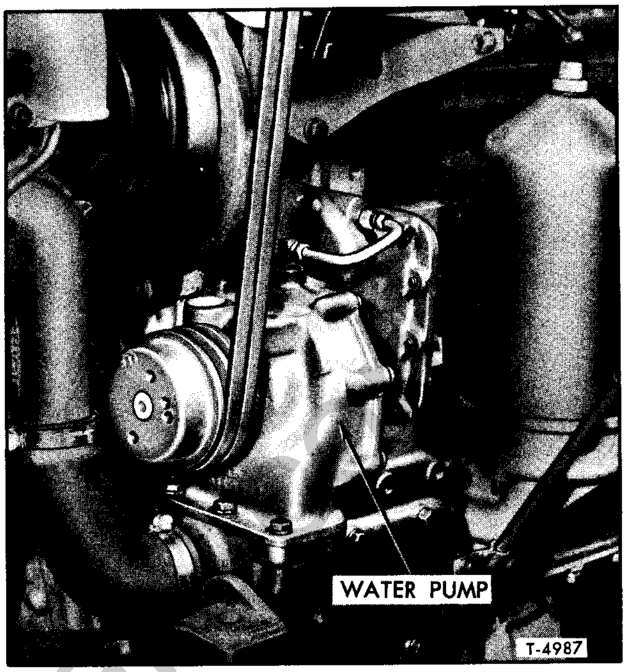


Figure 25—Water Pump Mounting (6V-53 Engine) (Typical)

Water Pump Removal

1. Open all block drain cocks and drain the cooling system.

2. Loosen and remove the water pump drive belts.

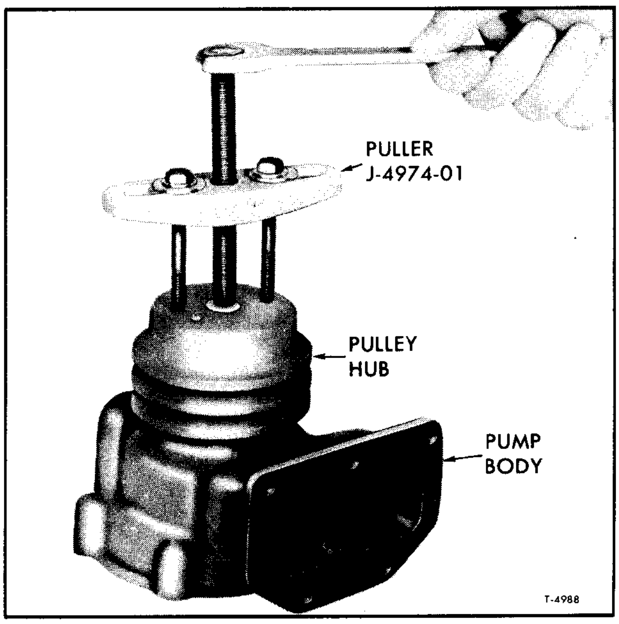


Figure 26—Removing Pulley (6V-53 Engine)

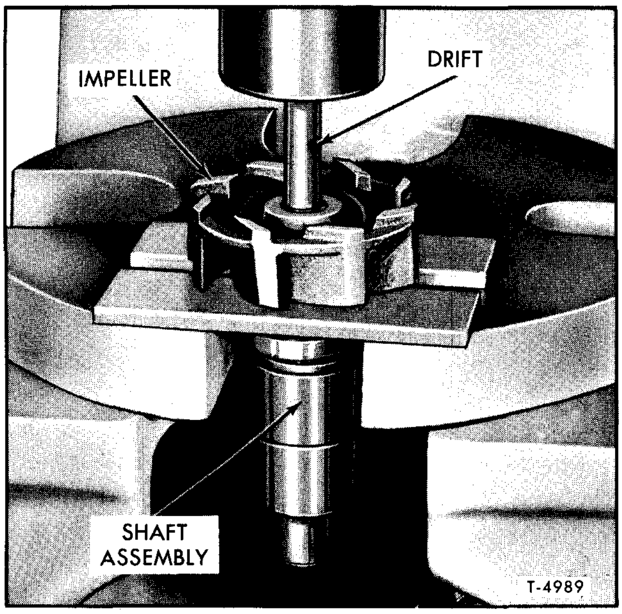


Figure 27—Removing Shaft from Impeller (6V-53 Engine)

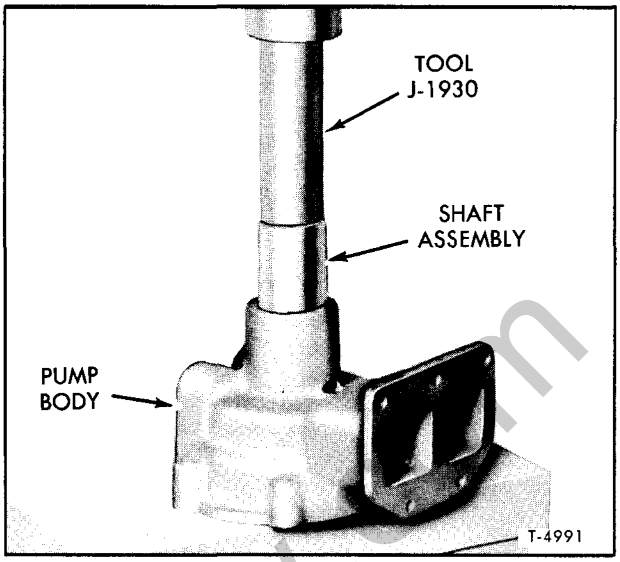


Figure 28—Pressing Shaft Assembly into Water Pump with Special Tool (J-1930)

NOTE: An idler pulley is used on some engines to adjust the water pump drive belt tension.

3. Loosen the hose clamps and slide the hose up on the water by-pass tube.

4. Remove the five bolts securing the water pump to the oil cooler housing. Remove pump.

Water Pump Disassembly

1. Note the position of the pulley on the shaft so that the pulley can be installed in the same position when the pump is assembled. Remove water pump pulley with puller (J-4794-01) as shown in figure 26.

2. Remove the water pump cover and discard the gasket.

3. Press the shaft and bearing assembly, seal and impeller out of the pump body as an assembly, by applying pressure on the bearing outer race with remover (J-1930).

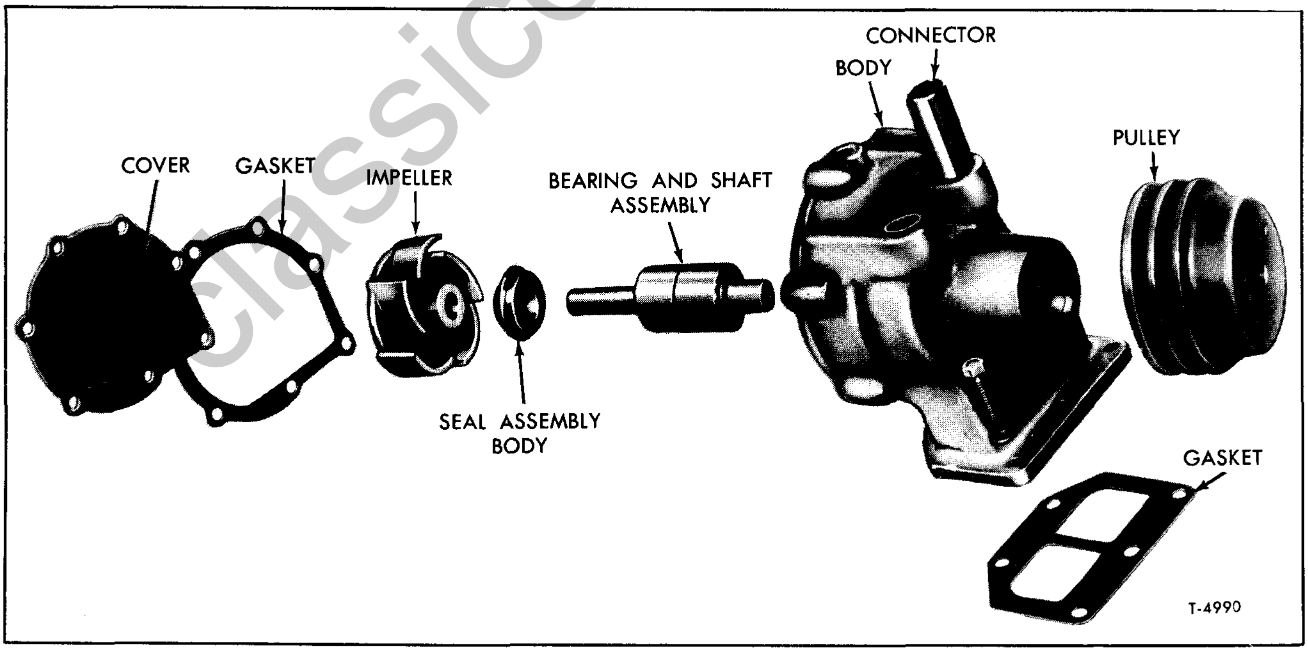


Figure 29—Water Pump (6V-53 Engine)

CAUTION: The bearing will be damaged if the pump is disassembled by pressing on the end of the pump shaft.

4. Press the end of the shaft out of the impeller as shown in figure 27, using plates and drift.

5. Remove the seal assembly from the pump shaft and discard assembly.

Inspection

Wash all of the pump parts except the bearing and shaft assembly in clean fuel oil and blow dry with compressed air.

NOTE: A permanently sealed and lubricated bearing is used in the bearing and shaft assembly and should not be washed. Wipe the bearing and shaft assembly with a clean, lint-free cloth.

Examine the impeller for damage and excessive wear on the impeller face which contacts the seal. Replace the impeller if it is worn or damaged.

Discard any bearing assembly that has a general feeling of roughness, is tight, has indications of damage or has been pitted by corrosion.

Water Pump Assembly

NOTE: Refer to figure 28.

1. Using installer (J-1930), apply pressure to the outer race of the bearing, as shown in figure 29. Press the shaft and bearing assembly into the pump body until the outer race of the bearing is flush with the outer face of the body.

CAUTION: The bearing will be damaged if the bearing and shaft assembly is installed by applying pressure on the end of the shaft.

2. Lightly coat the outside diameter of the new seal with sealing compound. Then with the face of the body and bearing outer race supported, install the seal by applying pressure on the seal outer flange only, until the flange contacts the body. Wipe the face of the seal with a chamois to remove all dirt and metal particles.

3. Support the pulley end of the shaft on the bed of an arbor press, and press the impeller on the shaft until the impeller is flush with the large end of the body.

4. Place the pulley on the bed of an arbor press. Place a suitable rod between the ram of the press and the impeller end of the shaft, then press the shaft into the pulley until the pulley is in its original position on the shaft.

5. Install the cover and a new gasket on the pump body. Tighten the cover bolts to 6-7 foot-pounds torque.

6. If equipment is available, run the pump dry at 1200 rpm for a minimum of 30 seconds, or as required, to assure satisfactory seating of the seal.

Water Pump Installation

1. Affix a new gasket to the flange of the water pump body.

2. Secure the water pump to the oil cooler housing with the five bolts and washers.

3. Install the hose between the water pump and water by-pass tube and tighten the hose clamps.

4. Install and tighten the belts.

NOTE: An idler pulley is used on some engines to adjust the water pump drive belt tension.

5. Close all the drains and refill the cooling system.

6. Start the engine and check for leaks.

6-71N IN-LINE WATER PUMP

On these engines the drive end of the pump shaft is supported by a sealed double-row combination radial and thrust ball bearing (fig. 30). The pump shaft serves as the inner race of the bearing.

A spring-loaded seal assembly and a water slinger, located between the seal and the bearing, prevent the coolant from passing along the shaft to the bearing. The carbon washer in the seal assembly bears against a steel insert that is pressed into the pump body. The insert may be replaced when worn.

The impeller is a press fit on one end of a tapered stainless steel shaft.

The pump is mounted on the front end of the blower (fig. 30) and is driven by the lower blower rotor shaft. The drive coupling, pressed on the end of the pump shaft, has an integral oil thrower that shrouds the flange end of the pump body and deflects the oil from the bearing.

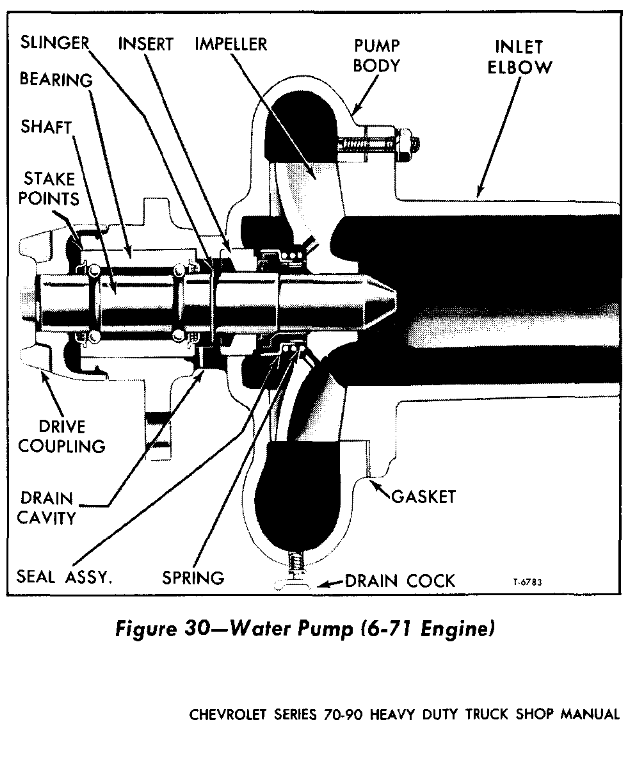


Figure 30—Water Pump (6-71 Engine)

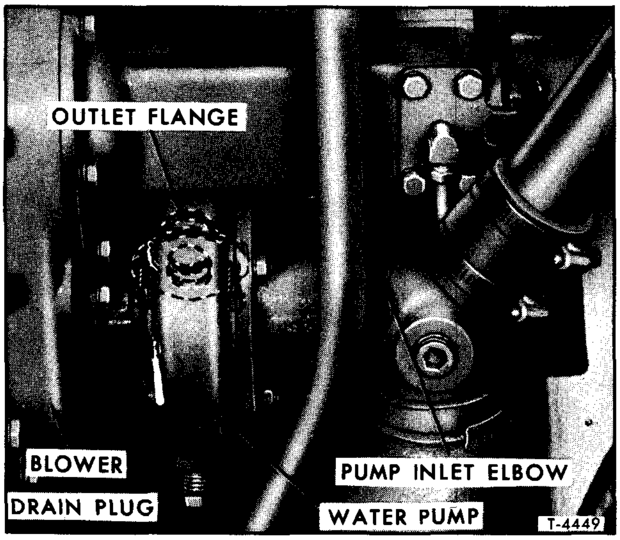


Figure 31—Water Pump Mounting (6-71 Engine) (Typical)

Water Pump Removal

Refer to figures 31 and 32 and remove the pump as follows:

1. Open the drain cock in the pump body and drain cooling system.
2. Loosen the hose clamps and force the water pump inlet hose against the pump inlet elbow.
3. Remove the two bolts and washers that attach the pump outlet flange to the cylinder block.

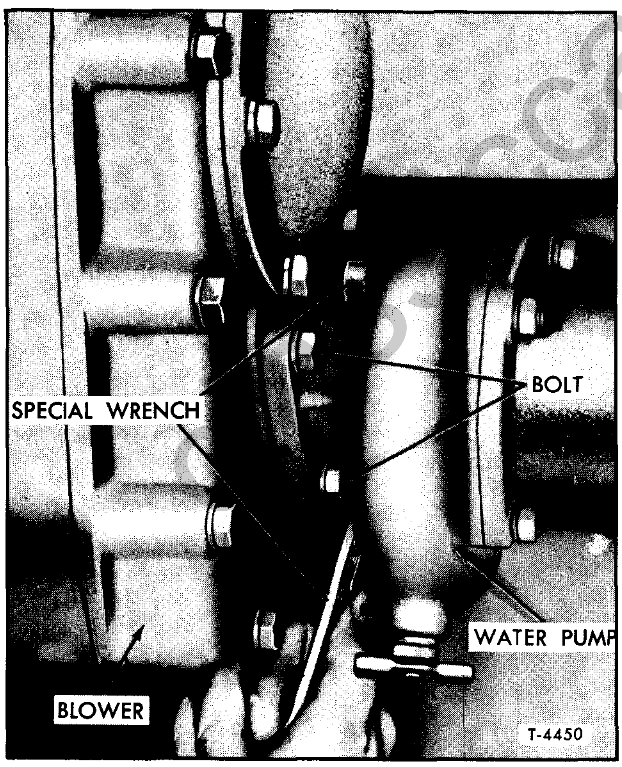


Figure 32—Loosening Inner Water Pump-To-Blower Attaching Bolt with Special Tool (J-4242)

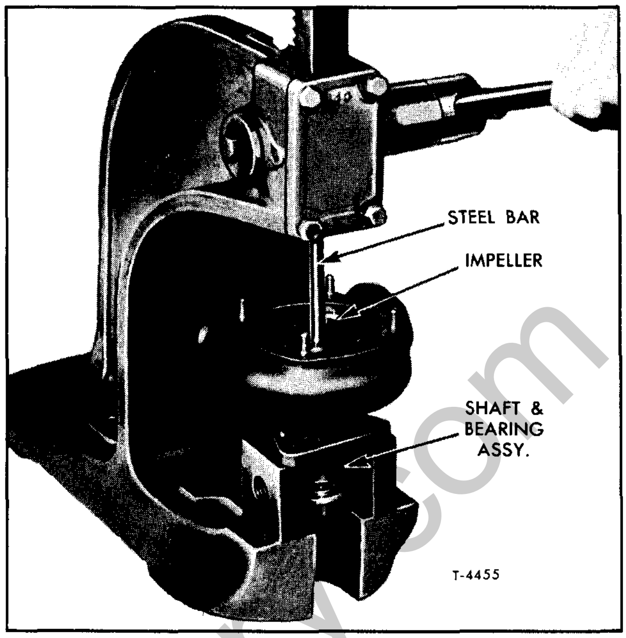


Figure 33—Pressing Water Pump Shaft from Impeller

4. Remove the three bolt and seal assemblies that attach the pump to the blower assembly, then use special tool (J-4242) to remove the inner cap screw (refer to fig. 32).
5. Withdraw the pump and remove the gasket and the outlet flange with packing ring.

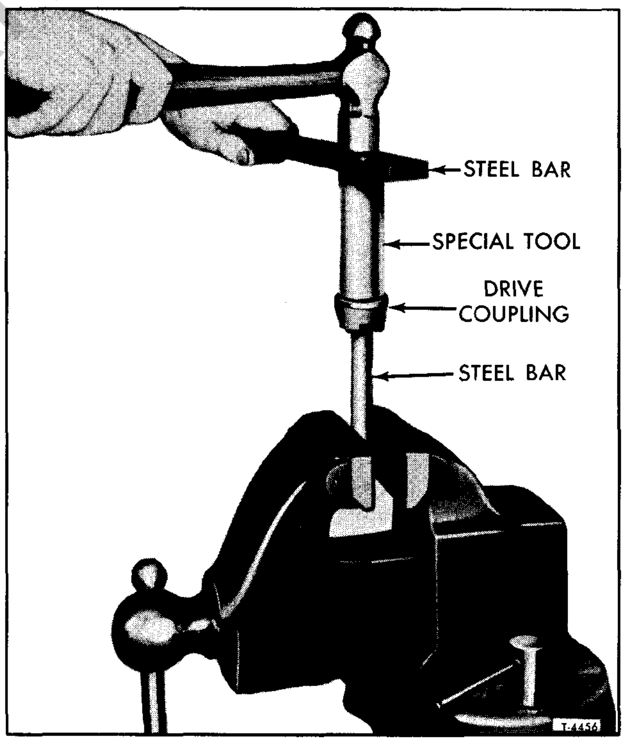


Figure 34—Removing Water Pump Drive Coupling from Shaft with Special Tool (J-1930)

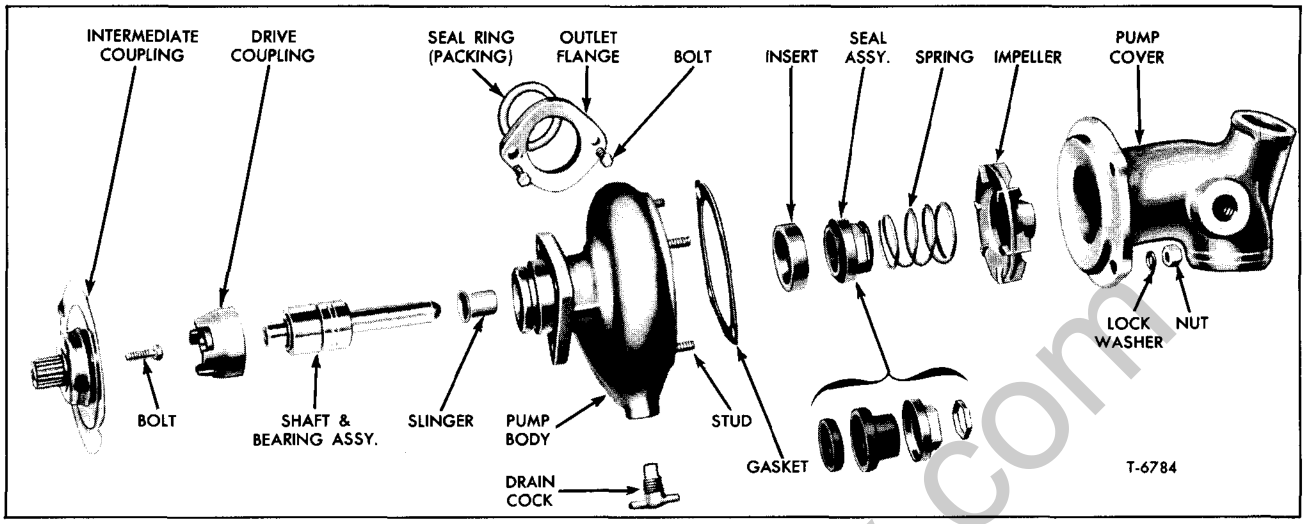


Figure 35—Water Pump Components (6-71 Engine)

Water Pump Disassembly

1. Remove the pump elbow inlet and gasket and discard gasket.

NOTE: Clean the corrosion from around the impeller and shaft before separating the shaft and bearing assembly from the impeller, seal, and water pump body.

2. Support the pump on its mounting flange in an arbor press as shown in figure 33. Place a short steel rod on the shaft and separate the shaft and bearing assembly from the impeller, seal, and pump body.

3. Remove the impeller and seal assembly from the pump body.

4. If the steel insert is worn excessively, tap or press it out of the pump body.

5. Remove the water slinger from the shaft.

6. If necessary, remove the pump drive coupling from the shaft with tool (J-1930) as shown in figure 39.

Inspection

Clean all of the parts except the shaft and bearing assembly. The sealed-type pump shaft bearing must not be immersed in a cleaning fluid since dirt may be washed in and the fluid cannot be entirely removed.

Revolve the pump shaft bearing slowly by hand. If rough spots are detected, replace the shaft and bearing assembly.

Examine the impeller for wear, and replace if necessary.

Examine the studs in the pump body. If it is necessary to replace a stud, use a good grade of sealant on the threads.

Water Pump Assembly

Refer to figures 30 and 35 and assemble the water pump as follows:

1. If a new steel insert is to be used in the pump body, make sure the counterbore in the pump body is thoroughly clean before installing a new insert. Dirt in the counterbore can cause misalignment between the insert and the carbon washer and result in a leak at this point. Start the counterbored end of the insert into the pump body. Then, press the insert in until it contacts the shoulder in the pump body. The insert has a 0.0015" to 0.0035" press fit in the pump body.

CAUTION: DO NOT mar the highly finished seal contact surfaces of the insert when pressing it into the pump body.

2. Install the slinger on the pump shaft with the flange of the slinger approximately 3/16" from the end of the outer race of the bearing.

3. Support the impeller end of the pump body on an arbor press, and insert the coupling end of the shaft and bearing assembly into the pump body. Then press against the outer race of the bearing until the bearing contacts the shoulder in the pump body. Stake the end of the pump body in three places to prevent the bearing from moving endwise.

4. With the surface of the water pump seal clean and free from dirt and metallic particles, apply a thin coat of liquid soap on the inside diameter of the rubber seal. Do not scratch or mar the surface of the carbon seal washer. Slide the seal assembly on the pump shaft until the carbon seal washer is seated firmly against the pump body insert. Then, install the spring with the small end toward the seal.

5. Support the bearing end of the shaft (not the drive coupling) on the bed of an arbor press. Then press the impeller on the shaft using impeller installer (J-22437) as shown in figure 36. On current engines the end of the shaft must be flush with

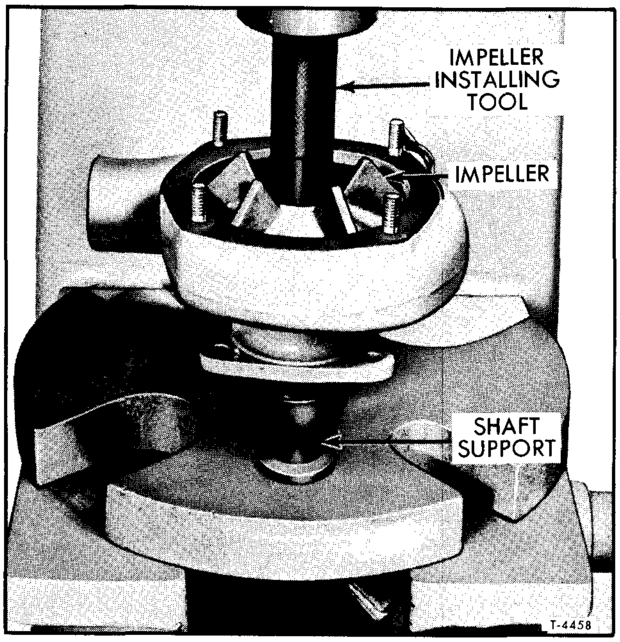


Figure 36—Installing Water Pump Impeller

the face of the impeller hub with the bearing being held against the shoulder in the water pump body.

6. Support the impeller end of the pump shaft on a suitable arbor and, press the coupling onto the shaft. The drive coupling must be flush with the end of the shaft. Make sure the drive coupling is tight on the shaft.

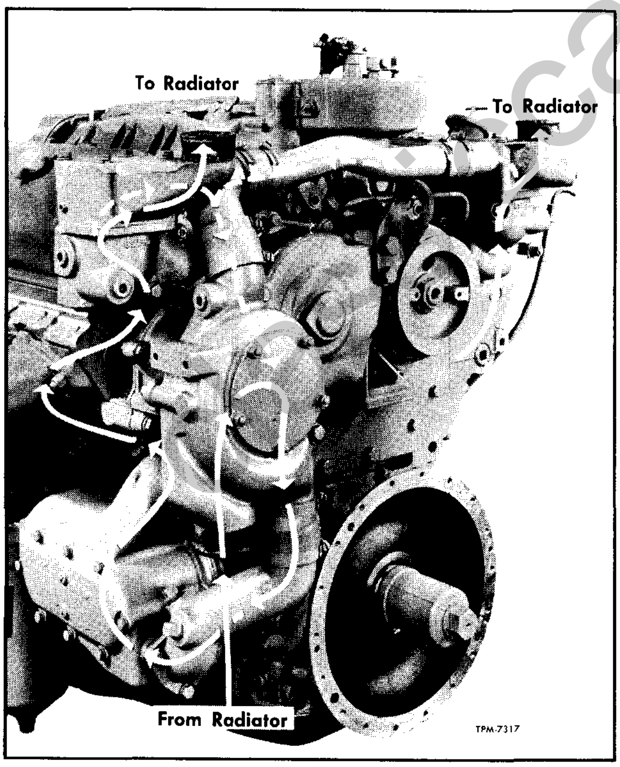


Figure 37—Water Pump Mounting (8V-71 Engine)

7. Rotate the shaft by hand to be sure the rear face of the impeller blades do not rub the pump body.

8. Place a new pump cover gasket against the bolting flange of the pump body. Slide the pump inlet elbow over the studs and secure it to the pump body with four washers and nuts.

9. If previously removed, install the drain cock in the pump body.

Water Pump Installation

Refer to figure 31 and install the water pump on the engine as follows:

1. Make sure the intermediate shaft coupling is secure. If it was previously removed, insert the splined end of the coupling into the mating splines on the blower rotor shaft. Then, draw the coupling in place with the 5/16"-24 x 1½" bolt. Tighten the bolt to 15-19 foot-pounds torque.

2. Place the pump outlet flange over the pump outlet with the flat side of the flange facing the pump body. Slip the packing ring over the pump outlet and next to the flange.

3. Using a new gasket at the bolting flange, place the pump against the blower end plate cover so that the lugs on the drive coupling mesh with the lugs on the intermediate shaft coupling. Secure the pump to blower with three bolts and seal washers.

4. Slide the pump outlet packing ring and packing flange against the cylinder block and secure the flange with two bolts and washers.

5. Slide the water pump inlet hose in place and secure it with the hose clamps.

6. Close the pump drain cock, and fill the engine cooling system.

NOTE: When filling the cooling system of certain models, it is necessary to open the vent valve at the top of the thermostat housing.

8V-71N ENGINE WATER PUMP

The centrifugal type water pump circulates the engine coolant through the cylinder block, cylinder heads, heat exchanger or radiator, and the oil cooler.

The pump is mounted on the engine front cover (fig. 37) and is driven by the front camshaft gear.

NOTE: The current water pump gear has 42 teeth and can only be used with the current 66 tooth front camshaft gear. Formerly the pump gear had 59 teeth which meshed with a camshaft gear that had 92 teeth. The former front camshaft gear must be replaced before installing a pump with the current pump gear.

A bronze impeller is secured to one end of a stainless steel shaft by a nut. A drive gear is pressed on the opposite end of the shaft. Two ball

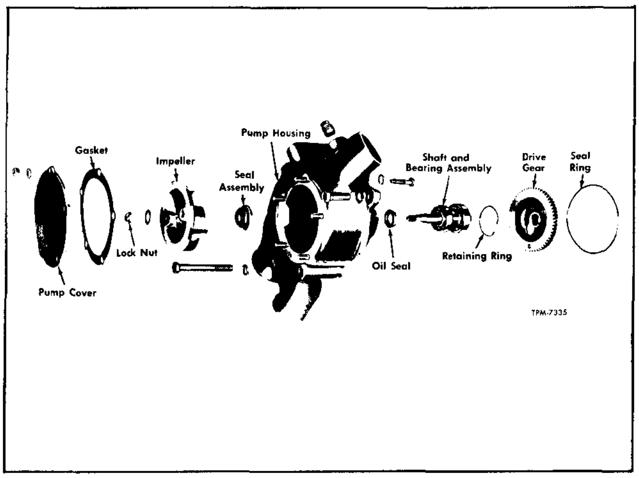


Figure 38—Water Pump Components (8V-71 Engine)

bearings are used to carry the shaft. The larger bearing is used at the drive gear end of the shaft to accommodate the thrust load (fig. 38).

An oil seal is located in front of the smaller bearing and a spring-loaded face type water seal is used behind the impeller. The impeller incorporates the ceramic seat for water seal.

Water Seal Replacement

The water seal can be replaced without removing the pump if the radiator, fan and fan shroud have been removed.

1. Remove the pump cover and gasket (fig. 38).
2. Remove the nut and washer and withdraw the impeller with puller (J-4794-01).

CAUTION: Use care to prevent damage to the ceramic impeller insert. Place the impeller on the bench with insert up.

3. Use water pump seal remover set (J-22150) to remove the seal with the pump on or off the engine (fig. 39).

a. Place the seal puller (J-22150-2) over the seal and into the two slots in the pump body casting.

b. Position the sleeve (J-22150-4) over the seal puller to support the seal puller.

c. Insert the slotted end of the arm (J-22150-5) through the seal puller and position the cover stud in the slot of the arm as shown in figure 39.

d. With the square head screw started in the tapped hole of the seal puller, finger-tighten the screw sufficiently to hold the arm in position.

e. Remove the seal by turning the screw clockwise.

4. Place a new water seal on the shaft. Press or tap the seal into the seal cavity with a suitable sleeve which has an inside diameter large enough to fit around the seal and rest on the brass cartridge lip.

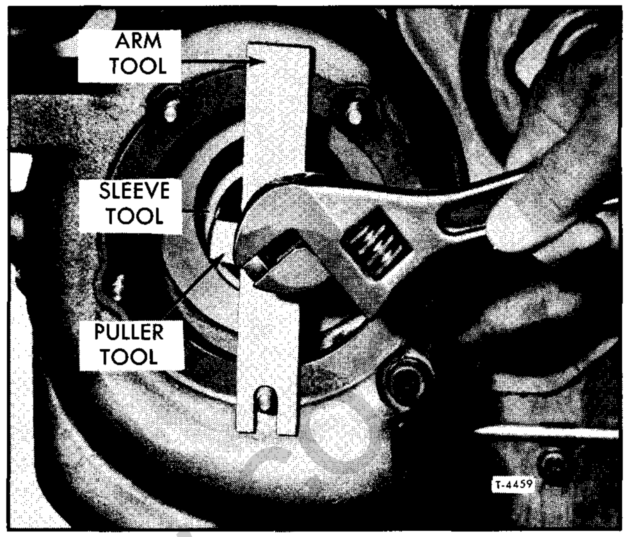


Figure 39—Removing Water Seal from Pump

5. Inspect the ceramic impeller insert for cracks, scratches, and bond to the impeller. If insert is damaged, replace it in following manner:

a. Bake the used ceramic insert and impeller assembly at 500°F., for one hour to remove the ceramic insert and wire brush the impeller bond area to remove the old adhesive, oxide, scale, etc. The ceramic insert can be removed easily from the counterbore while the adhesive is hot.

b. Wipe the impeller bond area and the grooved side of the new ceramic insert with a cloth soaked in a common solvent such as alcohol. Wipe clean with a dry cloth.

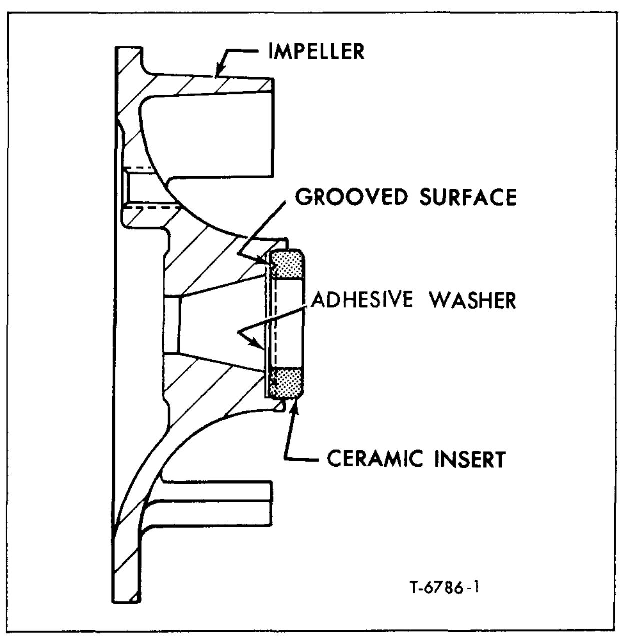


Figure 40—Impeller with Ceramic Inset

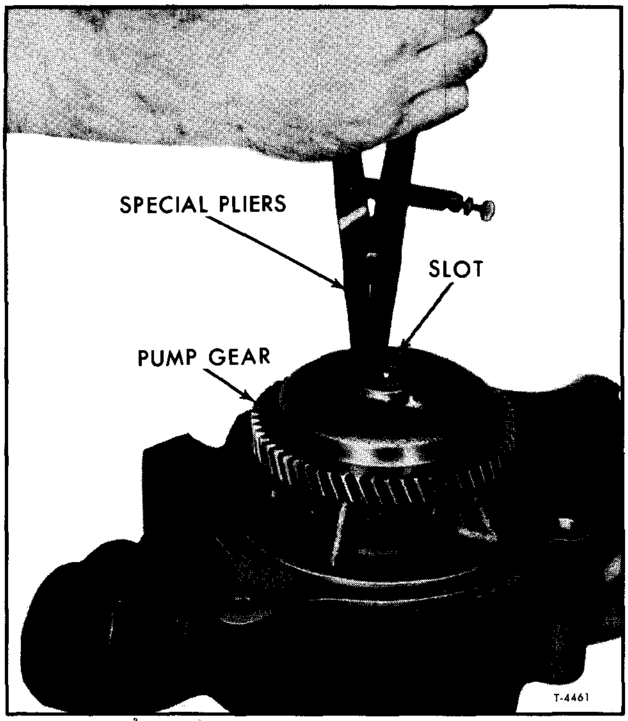


Figure 41—Removing Retaining Ring with Special Tool (J-4646)

c. Place the adhesive washer in the impeller bond area with the ceramic insert on top. The polished face of the ceramic insert should be visible to the assembler (fig. 41).

d. Clamp the ceramic insert and impeller together with a 3/8" bolt and nut and two smooth 1/8" thick flat washers. Tighten the bolt to 10 foot-pounds torque.

CAUTION: DO NOT mar polished surface of the ceramic insert.

e. Place impeller assembly in a level position, with ceramic insert up, in an oven pre-heated to 350°F., and bake the assembly for one hour.

NOTE: The face of the ceramic insert must be square with the axis of the tapered bore within 0.004". The pump shaft may be used as a mandrel for this inspection.

f. Remove the impeller from the oven and after it has gradually cooled to room temperature, install it in the pump. Do not loosen and remove clamping bolt and washers until assembly cools.

6. Make sure the mating surfaces of the water seal and the ceramic insert on the impeller, are free of dirt, metal particles, and oil film. Then, install the impeller on the shaft. Place the washer and lock nut on the shaft; tighten the nut to 45 to 50 foot-pounds torque.

7. Loosen the clamps and remove the hose from the water outlet opening of the pump.

8. Insert a feeler gauge into the water outlet opening of the pump. The minimum clearance between the impeller and the pump housing must be 0.015".

9. Use a new gasket and install the water pump cover. Tighten the nuts or bolts securely.

NOTE: When the cover is secured by cadmium plated bolts with nylon inserts, inspect them carefully to make sure the nylon inserts are in place and protrude sufficiently beyond the threads to prevent leakage. Under no circumstances should a standard bolt be used.

10. Install and secure the hose on the water outlet opening with the clamps.

Water Pump Removal

1. Drain the cooling system.
2. Remove the radiator, fan shroud and fan, if necessary.
3. Loosen the hose clamps and remove the hoses from the pump housing.
4. Remove the pump housing-to-engine front cover mounting bolts and detach the pump. Use care to prevent damage to the gear teeth when disengaging the pump gear from the camshaft gear.

Water Pump Disassembly

1. Turn the pump gear so the slot is over the ends of the bearing retaining ring, insert pliers (J-4646) into the slot and with the aid of a small screwdriver remove the ring from the groove (fig. 41).
2. Remove the pump cover and gasket.
3. Hold the gear securely and remove the impeller nut and washer.

CAUTION: While holding gear, use care to prevent damage to the gear teeth.

4. Use puller (J-4794-01) to remove the impeller.
5. Press the shaft, bearings, and pump gear assembly out of the pump housing.
6. Place the gear on the bed of an arbor press with the shaft extending downward, then place a short piece of 5/8" diameter bar stock between the shaft and ram of the press and press the shaft out of the gear as shown in figure 42.
7. Support the shaft assembly on inner race of the larger bearing with the threaded end down. Place flat stock between the ram of press and the shaft and press the pump shaft out of the large bearing.
8. Invert the shaft, support it on the inner race of the small bearing and repeat the process described in Step 7.
9. If necessary, remove water seal as described previously under "Water Seal Replacement."

10. Push oil seal out of the housing.

NOTE: New seals must be used as replacements each time the water and oil seals are removed.

Inspection

Wash all the pump parts in clean fuel oil; dry with compressed air and inspect them for cracks, other damage and wear. Replace damaged or worn parts.

Inspect the ceramic impeller insert for cracks, scratches, and bond to the impeller. The insert may be replaced if necessary as directed previously under "Water Seal Replacement."

The bearings should be examined for corrosion, pitting, wear, and freedom of movement. Apply engine oil to the bearings, hold the inner race and slowly revolve the outer race to check for roughness. Replace the bearings if necessary.

Water Pump Assembly

1. Apply a film of engine oil to the circumference of the oil seal and place it on installer (J-8501) with the lip of the seal away from tool.
2. Affix the installer (J-8501) on the handle (J-7079-2). Insert the seal into the pump housing and tap the seal into place.
3. Place the pump housing on the bed of an arbor press. Insert the water seal into the cavity in the pump housing and with a sleeve large enough to fit around the seal and rest on the brass cartridge lip, press the water seal evenly into place.
4. Lubricate the bearing bores and shaft bearing surfaces. Reverse the procedure for "Disassembly," and install the bearings on the shaft.

CAUTION: Apply pressure to the inner races of the bearings only during assembly on the shaft.

5. Support the pump housing on bed of the arbor press with cover side down. Lubricate the water seal contact surface of the shaft and insert threaded end down into the pump housing. Press the shaft and bearing assembly into place by applying pressure on the outer race of the large bearing.

CAUTION: Support the pump housing so the studs (if used) do not rest on the bed of arbor press.

6. Install the bearing retaining ring.
7. Place the water pump with impeller end of shaft supported on bed of an arbor press. Place the gear between the shaft and the ram of the press. Press the gear on shaft so it is against the inner race of bearing.

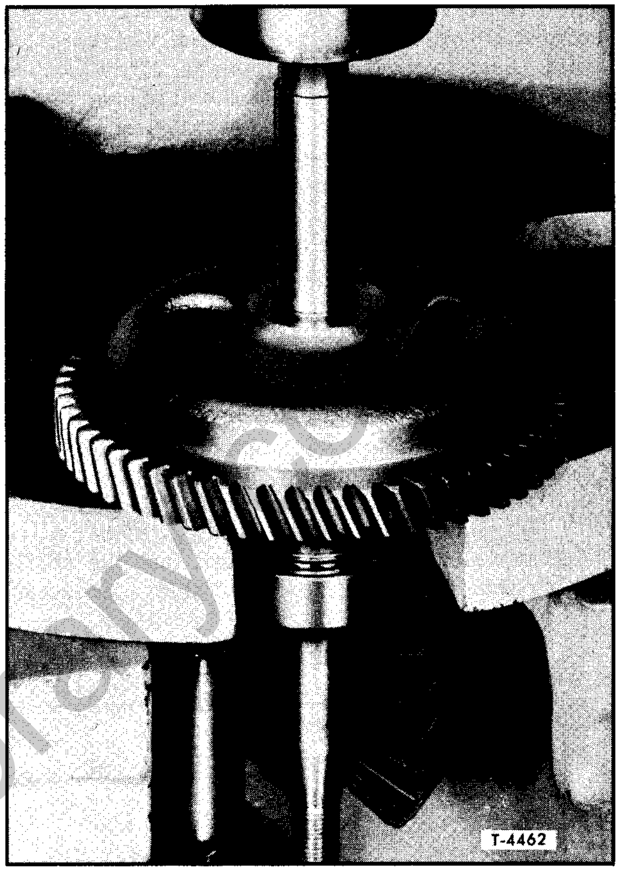


Figure 42—Pressing Shaft Out of Gear

CAUTION: A support must be placed between the pump shaft and the bed of the arbor press. Do not allow pump housing or studs (if used) to rest on the bed of the press while pressing on the gear.

8. Make sure the mating surfaces of the water seal and ceramic insert are free of dirt, metal particles, and oil film. Then, press the impeller on shaft.
9. Place washer and nut on the shaft. Hold the pump gear securely and tighten nut to 45 to 50 foot-pounds torque.

CAUTION: DO NOT damage gear teeth while holding the gear.

10. Use a new gasket and install the water pump cover. Tighten nuts or bolts securely.

NOTE: On some models, two special bolts with a teflon taped area, are used along with the studs and nuts to fasten the pump cover to the pump body. It is important that the same special bolts (new or used) be reinstalled. Whenever reusing these bolts, inspect them carefully to make sure the teflon tape is in place and in good condition to prevent leakage. Under no circumstances should a standard bolt be used. Tighten these bolts to 20 to 25 foot-pounds torque.

11. Install the hose on the water outlet opening and secure it with clamps.

Water Pump Installation

1. Affix the neoprene seal ring into groove of pump housing. Mount the pump on the engine so the pump gear meshes with the camshaft gear, and install and tighten the mounting bolts.
2. Slide the hoses into position, then install and tighten the hose clamps.
3. Fill the cooling system as recommended in previous text for cold or warm weather operation.
4. Start engine and check for leaks.

SPECIFICATIONS

The cooling system capacities listed below apply to vehicles with standard equipment only. Because of some optional equipment which may be used, air conditioning, larger engine, water filter, increased cooling, etc., the capacity of cooling system will vary. For the purpose of obtaining an accurate cooling system capacity before adding anti-freeze to an optional equipped vehicle, it is recommended that the cooling system be first replenished until visible in filler opening and then drained into a graduated container of which the contents can be measured.

COOLING SYSTEM CAPACITIES (QTS.) INCL. HEATER

TRUCK MODELS	QUARTS*	
	U.S.	IMPERIAL
HM, JM 80	41	34¼
HV, JV 70	38	31¾
TM 80	42	35
TV 70	33	27½
HI, JI, MI 90	45	37½
MH 90	56	46¾
DH FH 90	63	52½
DI, FI 90	44	36¾
ENGINES		
NH 230	50	41¾
NH 250	50	41¾
NHC 250 (w/increased cooling)	52	43¼
NHCT 270	52	43¼
NTC 335	53	44¼

*Add approx. 2 quarts if increased cooling is used.

ENGINE THERMOSTATS

ENGINE	NUMBER USED	MEAN TEMP. (°F)	STARTS TO OPEN (°F)	FULLY OPEN (°F)
V6 Gasoline	2	170	167-172	192
6V-53 Detroit Diesel	2	175	174-176	190
6-71N Detroit Diesel	1	180	179-181	195
8V-71N Detroit Diesel	2	180	179-181	195
Cummins Diesel	1	170	170	185

ENGINE OVERHEAT SWITCH

Switch Contacts Close At:	
Gasoline Engines	225°F
Detroit Diesel Engines	215°F
Cummins Diesel Engines	205°F

SECTION 6M

ENGINE FUEL SYSTEM

This group is divided into five sections as shown in Index below:

AIR CLEANERS
(ALL ENGINES)

Contents of this section are listed in Index below:

GASOLINE ENGINES

Air cleaners should be inspected every 3,000 miles minimum and serviced whenever dirt becomes visible in element or oil. Under adverse conditions or extensive operation on dusty or sandy roads, unit should be cleaned every day or at least every 200 miles. Air cleaners on vehicles operating in dust storm areas should be cleaned immediately after such storms occur.

PAPER ELEMENT TYPE

A paper element-type air cleaner (figs. 1 and 2) (dry or paper wetted) is used on gasoline engine. Inspect element assembly for damage and replace when damaged or excessively dirty.

1. Remove wing nut from stud at top of air cleaner, then lift cover and element from base.
2. The following procedure is to check and service paper type element.

a. To determine if an air filter element requires cleaning or replacement, use air filter viewer, A.C. Part Number 6484631 which has a special lens for this purpose.

b. Position the viewer as shown in figure 3 and turn on viewer light. A dirt-clogged element prevents the light from being visible from outside.

c. The paper wetted type air cleaner has been impregnated with oil and cannot be cleaned. When dirt-clogged or when light as described above is not visible, the element must be replaced.

d. Some dry elements are washable; refer to decal (fig. 4) for instructions. Clean element by shaking out accumulated dirt, or clean by washing with water and detergent ONLY. Rinse until water runs clean. Shake off excess water and dry. DO NOT OIL ELEMENT.

IMPORTANT: DO NOT USE AIR PRESSURE TO CLEAN OR DRY ELEMENT.

NOTE: Install a new element after five cleanings.

e. If the dry type element is cleaned, recheck after cleaning or washing as described above, and every 3,000 miles thereafter. Under normal driving conditions element should be checked every 6,000 miles.

3. Re-assemble and install in reverse order of removal and disassembly procedures.

OIL BATH TYPE

On cleaners mounted to carburetor or on cab dash, loosen clamp screw, then lift assembly to remove. Loosen thumb screw on top, then separate cover and element from reservoir.

Drain oil from reservoir. Clean all parts in cleaning fluid and dry thoroughly. Do not use compressed air on element. Fill reservoir to level mark with same grade oil used in engine. Install element and reservoir in reverse order of their removal and disassembly.

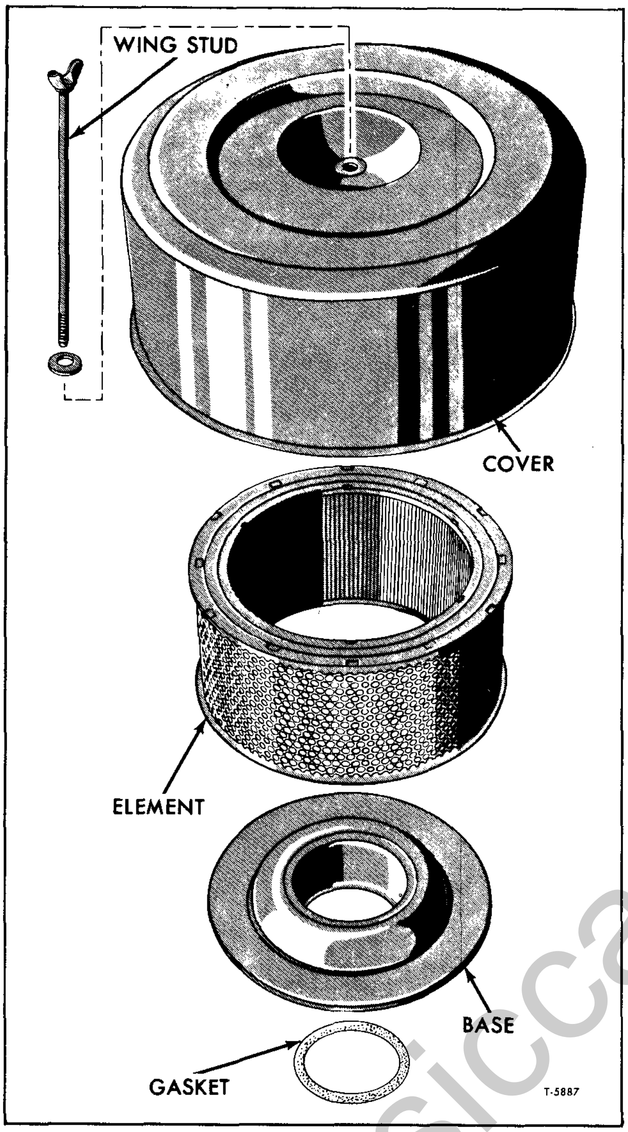


Figure 1—Air Cleaner (Gas—Dry Element Type) (Typical)

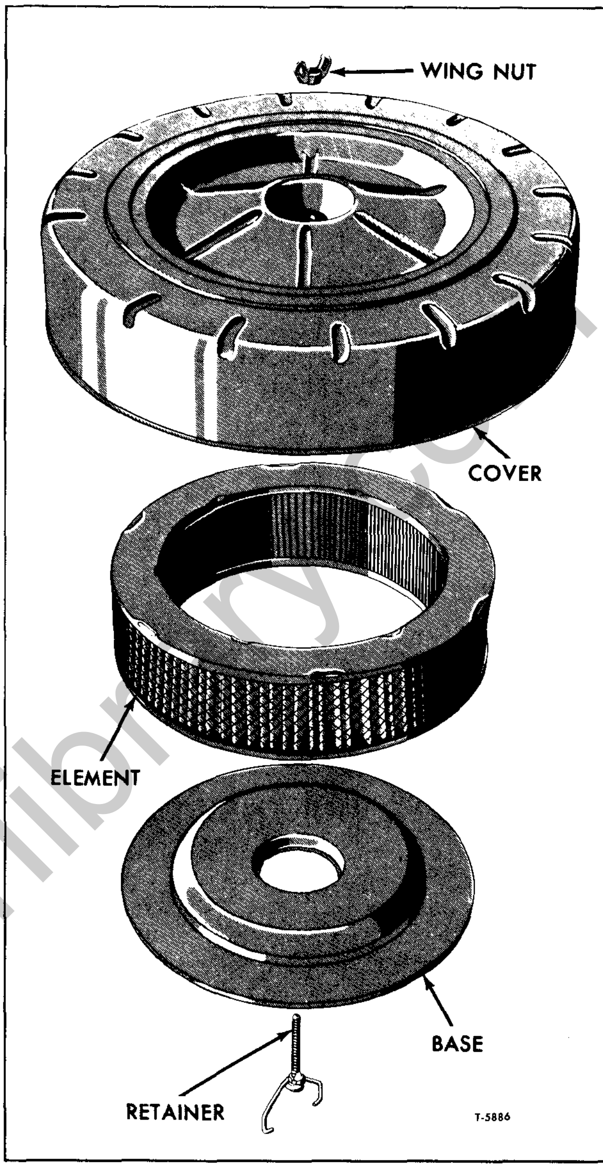


Figure 2—Air Cleaner (Gas—Wetted Element Type) (Typical)

DIESEL ENGINES

Several types of air cleaners are used. The oil bath type and the paper element type. However, depending on vehicle model, each type is mounted in a different manner.

Air cleaners should be inspected every 3,000 miles minimum and serviced whenever dirt becomes visible in the element or oil. Under extreme dirty conditions inspection may be required daily, or every 200 miles. Air cleaners on vehicles operating in dust storm areas should be cleaned immediately after such storms occur.

On some vehicles having paper element, an air restriction gauge indicates when element needs servicing.

WARNING—DIESEL ENGINE

USE EXTREME CAUTION TO BE SURE THAT ALL VOLATILE CLEANING FLUID (GASOLINE, KEROSENE, ETC.) IS REMOVED FROM AIR CLEANER AT TIME OF CLEANING. UNCONTROLLED FUEL ENTERING THE COMBUSTION CHAMBER IN THIS MANNER CAN CAUSE THE ENGINE TO "RUN-AWAY" AND POSSIBLY DESTROY ITSELF AND CAUSE INJURY TO PERSONNEL.

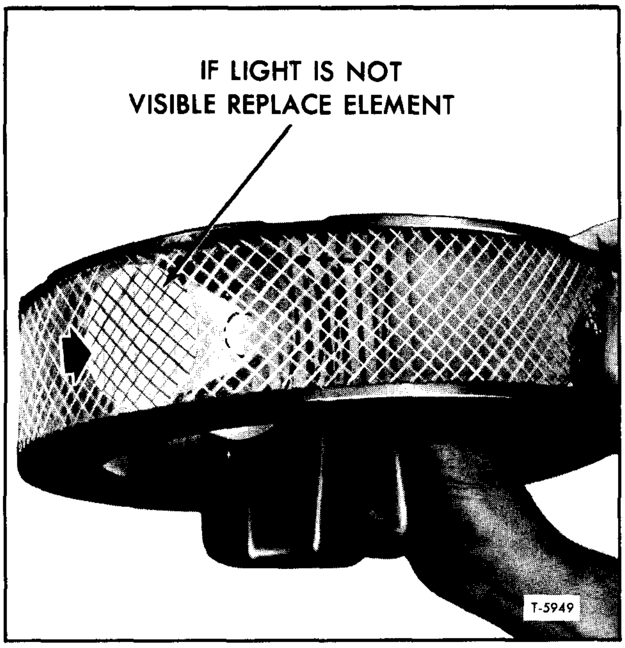


Figure 3—Checking Element with Air Filter Viewer

OIL BATH (TYPES SHOWN IN FIGS. 5 & 6)

An oil bath air cleaner is used on some models as shown in figures 5 and 6. Service as follows:

1. Loosen clamp screw or nut and remove cup assembly. Drain oil from assembly and clean in cleaning fluid to remove all accumulated deposits.

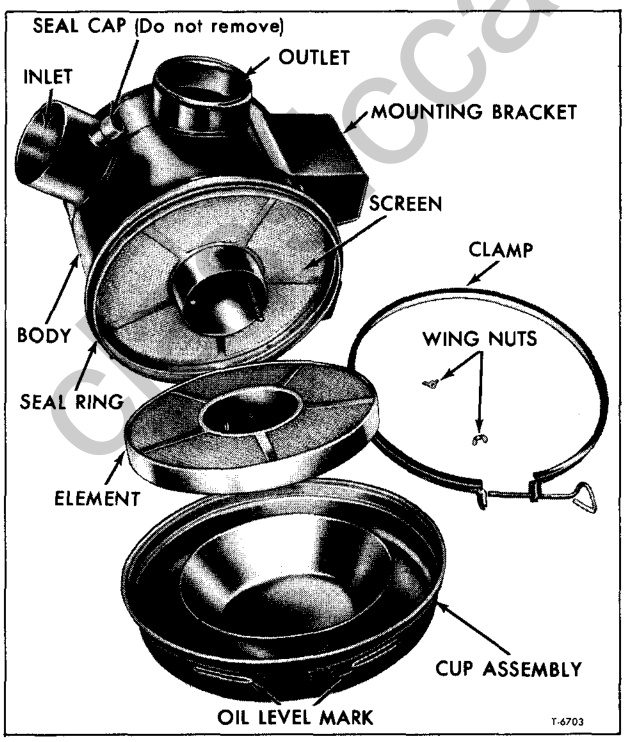


Figure 5—Oil Bath Air Cleaner (Typical for Diesel)

Figure 4—Typical Dry Element Cleaner Label

2. Remove element downward and out of cleaner body. Some cleaner elements are held in cleaner body with two wing nuts (fig. 5).

3. Slush element up and down in bath of cleaning fluid until all oil and dirt deposits are removed. Permit element to dry thoroughly before installing, but do not use compressed air.

4. Reinstall element in cleaner body, being sure element is pushed up as far as possible.

5. Fill cup or reservoir up to "OIL LEVEL" mark using same grade oil used in engine. Install cup to body; make sure seal ring is in good condition and properly installed. Tighten clamp securely.

IMPORTANT: When connecting hoses to intake manifold or aluminum housing, torque the clamp screws 16 to 20 foot-pounds.

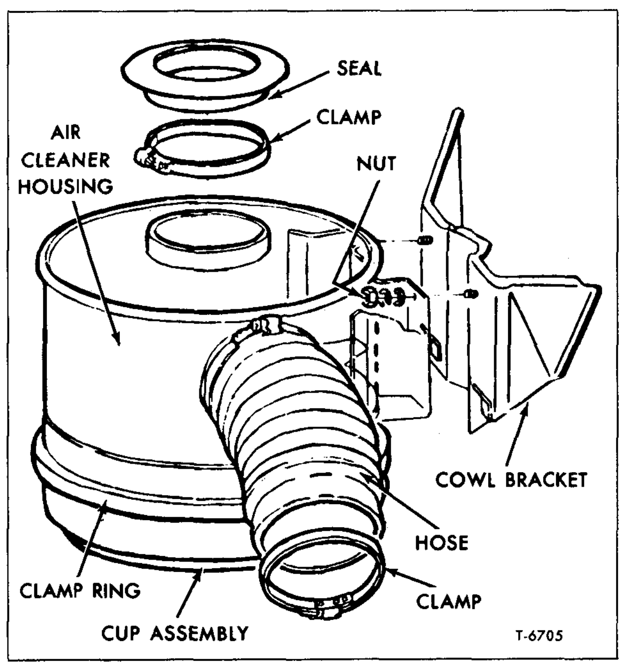


Figure 6—Air Cleaner (Typical for Diesel)

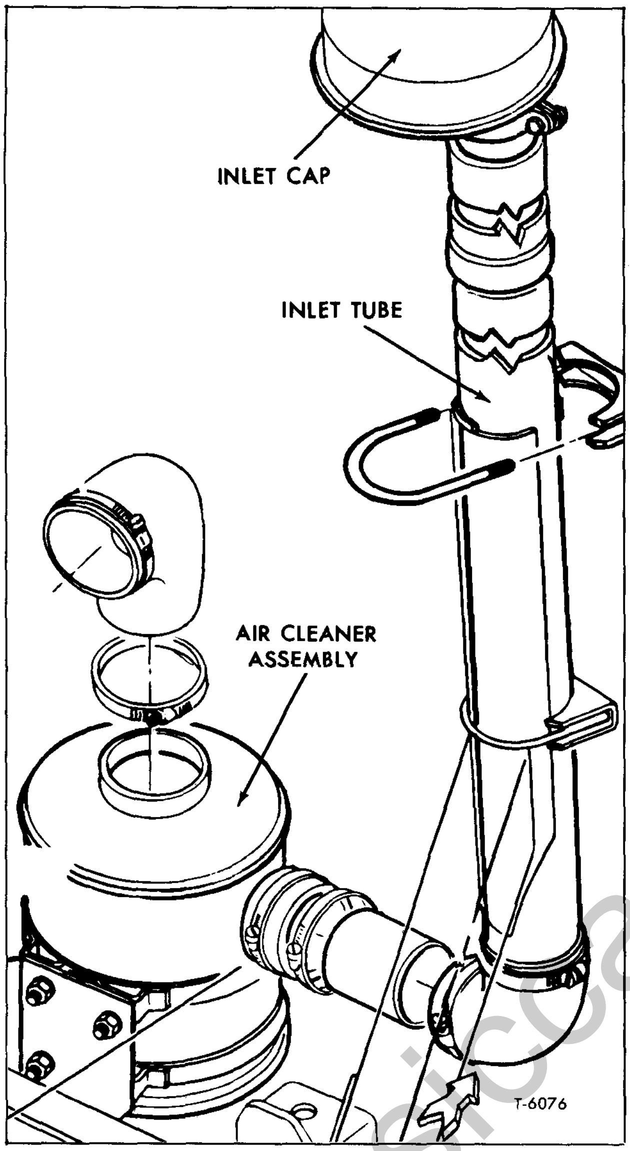


Figure 7—Air Cleaner Installation (Typical for Diesel)

OIL BATH (TYPES SHOWN IN FIGS. 7 & 8)

IMPORTANT: Keep all fittings, connections, tubing, elbows, and inlet cap, as shown in figure 7, tightened securely. Also, check inlet cap for foreign material and clean as necessary.

1. Loosen thumb screws which attach reservoir to cleaner body (fig. 8), rotate slightly to left and lower reservoir.

2. Drain oil from reservoir and clean in cleaning fluid to remove all accumulated deposits.

NOTE: Cleaner has a removable pre-filter that prevents dirt and fibers from entering main filter.

3. To remove pre-filter, press upward and turn to left until unlocking tabs line up with vertical slots, then lower element. Slush element up and down in cleaning fluid until all oil and dirt deposits are removed. DRY ELEMENT THOROUGHLY OF CLEANING FLUID BEFORE INSTALLING. Reinstall element in cleaner body.

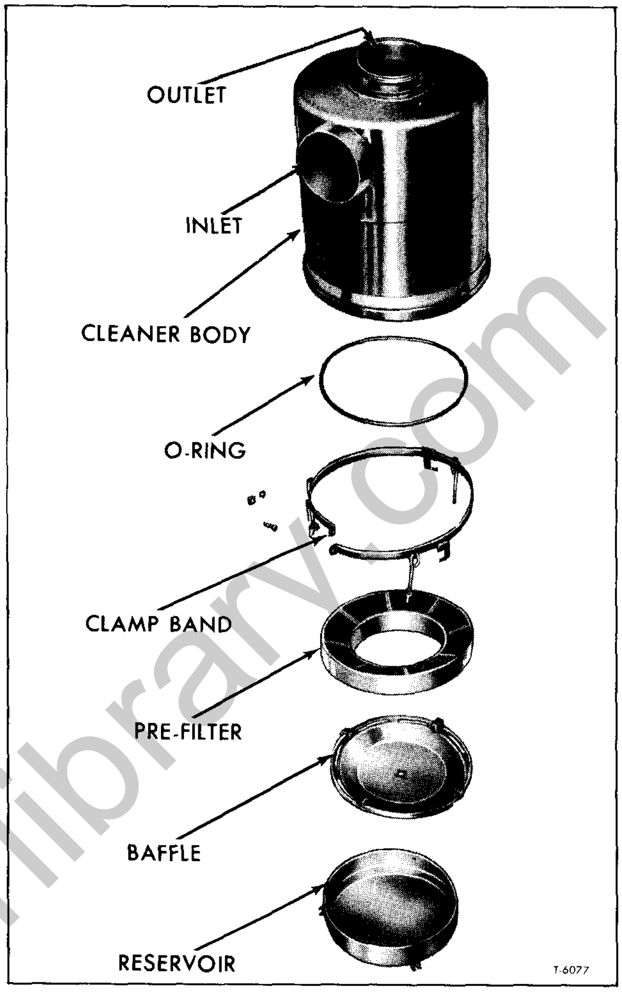


Figure 8—Oil Bath Air Cleaner

4. Fill air cleaner cup to indicated level with S.A.E. 20 oil in summer and S.A.E. 10 or lighter oil in winter. Refer to Air Cleaner Instruction label.

NOTE: Inspect air cleaner frequently. Empty cup, clean out and refill when oil becomes thick with suspended dust or when ¼ of oil has been displaced with sediment. Under severe conditions service daily or more often if necessary.

DRY TYPE AIR CLEANER

The standard air cleaner used on some vehicles has a dry type paper element (fig. 9). Fresh air enters the air cleaner at the top and all foreign matter, dust, and dirt is prevented from entering the engine by the filter element. The larger particles will drop to the bottom of the air cleaner and will be expelled through a vacuator valve. This is a continuous and automatic process.

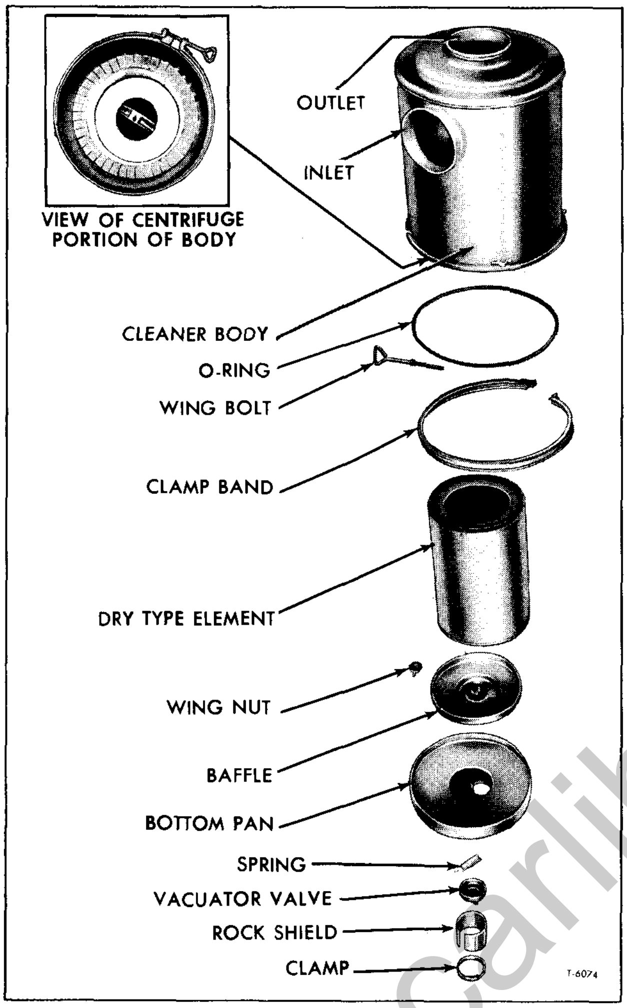


Figure 9—Dry-Type Air Cleaner

NOTE: On trucks equipped with air restriction gauge, or indicator (figs. 11 and 12), service paper element when gauge registers "25" (inches of water) or red signal reaches "SERVICE LEVEL."

This 2-stage dry air cleaner consists of a centrifuge and final filter. The centrifuge throws out most of the heavy dust particles and all of the water.

Element Replacement (Fig. 9)

1. Loosen wing bolt in clamp band until bottom pan can be lowered from cleaner body.
2. At bottom of element, remove wing nut. Pull element downward to remove from shell.
3. Install new or cleaned element in reverse order of removal.

NOTE: If replacement is necessary, specify GM replacement element.

Element Cleaning

During cleaning, use extreme caution so as not to puncture or otherwise damage paper element.

Figure 10—Air Cleaner Labels

Instructions on decal attached to air cleaner should be noted as shown in figure 10. Element can be cleaned by either of two methods as follows:

Dry Air Method. Direct dry, clean air up and down pleats on the clean air side of element. Use caution that air pressure does not exceed 100 psi. Maintain a reasonable distance between nozzle and element.

Washing Method. Washing is especially effective for oily or soot laden filters. Prepare a solution of Donaldson D-1400 detergent, or commercial non-sudsing detergent (2 oz. to 1 gallon warm 100^{o} water). Soak element for 15 minutes, then rinse with clean water and air dry completely. A fan or air draft may be used, but DO NOT HEAT ELEMENT TO HASTEN DRYING. Inspect by placing a bright light inside element. Light will show through any hole or rupture. Damaged element must be replaced.

IMPORTANT: Filter element should be replaced after six cleanings or annually.

AIR FILTER RESTRICTION GAUGE (Fig. 11)

On vehicles with air restriction gauge service air cleaner element when gauge registers "25" (inches of water).

AIR FILTER RESTRICTION INDICATOR (Fig. 12)

The air filter restriction indicator is located in the air inlet manifold, and is readily visible when engine compartment is open. The indicator itself requires no service other than resetting.

This device serves to warn that the air filter is dirty and should be serviced. The indicator is

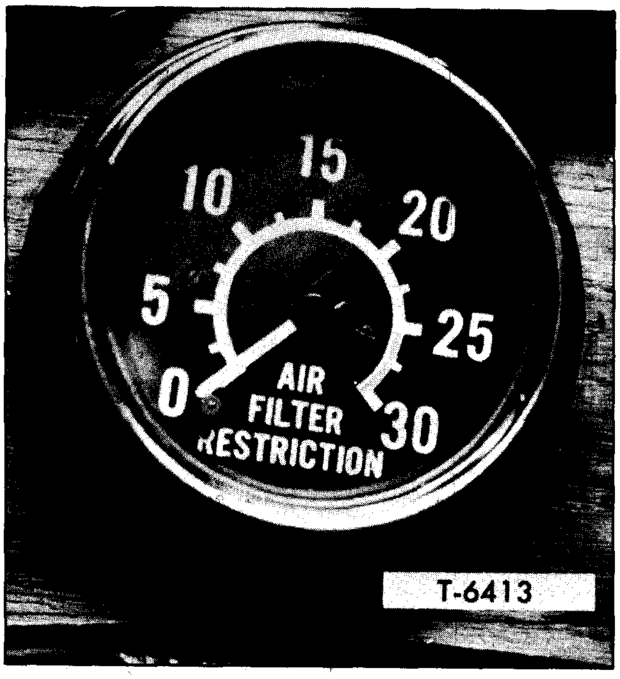


Figure 11—Air Filter Restriction Gauge

Figure 12—Air Filter Restriction Indicator

so constructed that the warning notice is given before any damage will occur to the engine as the result of a clogged filter element.

When the filter element is clogged to the point that air flow is restricted to sufficient degree to activate indicator valve, the indicator will show a red ring in the transparent area of the body ("SERVICE LEVEL"). This is a signal that the air cleaner must be serviced. After servicing air cleaner as described previously in this section, reset the indicator by depressing and releasing button on top of indicator body. This will cause the red ring to move out of the transparent body area (refer to fig. 12).

GASOLINE ENGINES

Contents of this subject are listed in Index below:

ACCELERATOR AND THROTTLE LINKAGE ADJUSTMENT

CONVENTIONAL CAB MODELS

(Refer to Figure 1)

1. Disconnect the accelerator pull-back spring. Disconnect the accelerator relay rod assembly at the carburetor. Loosen the jam nut on the accelerator relay rod.
2. Block pedal down firmly against floor mat.
3. Hold carburetor lever in full throttle position and turn relay rod until end of rod fits freely into carburetor lever. Tighten jam nut on relay lever.
4. Connect accelerator relay rod to carburetor lever and release accelerator pedal. Connect pull-back spring.

STEEL TILT CAB MODELS (70-80 SERIES)

(Refer to Figure 2)

1. Disconnect pedal and throttle return springs, then check front and rear cable clamps for proper tightness on accelerator control cable assembly.
2. Disconnect rod end assembly "A" from relay lever. Verify that rod end assembly "A" is threaded on the cable assembly ½-inch, then reconnect ball joint to relay lever.
3. Depress pedal to ¼-inch from floor.
4. Disconnect rod end assembly "B" from throttle lever.

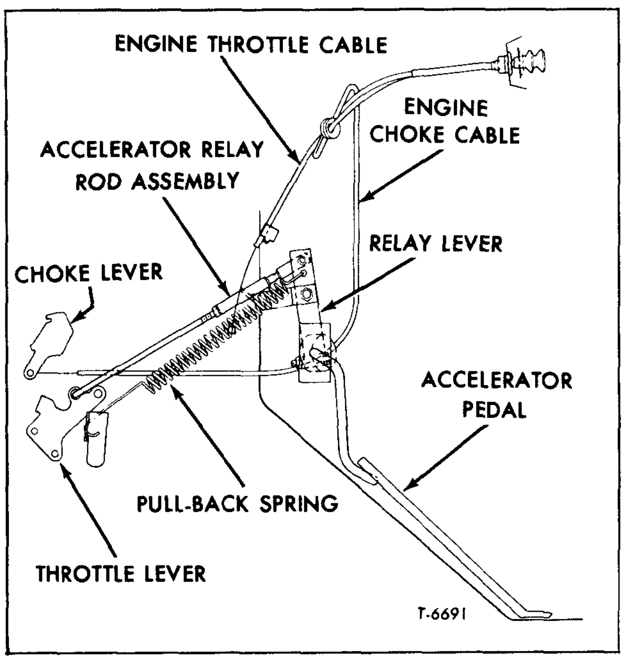


Figure 1—Accelerator Linkage (HM, JM80)

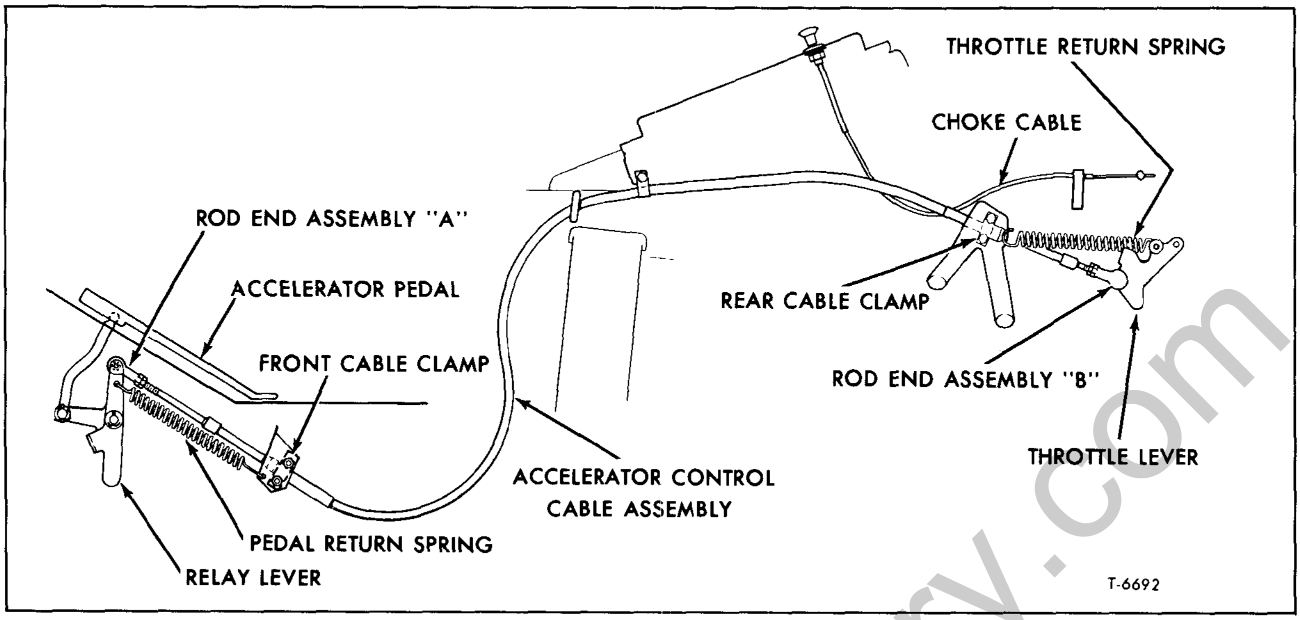


Figure 2—Accelerator Linkage (TM80)

5. Move throttle lever to full throttle (wide open). Thread ball joint on cable assembly, sufficiently, to provide free-entry of rod end assembly "B" into throttle lever.

NOTE: If additional adjustment is required, adjust position of rod end assembly "A" on cable assembly, accordingly. Minimum allowable thread engagement at either ball joint is ¼-inch.

6. Reconnect pedal and throttle return springs.
7. Check operation of linkage to make sure carburetor throttle lever is at full throttle before accelerator pedal reaches floor mat. Readjust, if necessary.

MANUAL CHOKE CONTROL

Adjust manual choke control so choke valve is fully open (vertical) when choke control knob is pushed in. When necessary to change choke setting proceed as follows:

1. Loosen choke wire screw at carburetor.
2. Position choke control knob 1/8-inch from instrument panel, then move choke lever to fully open position and tighten screw securing choke wire to lever on carburetor.
3. Check operation of choke to make sure choke valve closes completely as knob is pulled out. Reposition choke cable housing in clamp if there is interference before choke valve is completely closed. Adjustment of fast idle mechanism is covered later under "Carburetors."

HAND THROTTLE ADJUSTMENT

1. Check accelerator linkage for free movement and to be sure return spring returns linkage to idle position.
2. Check to see that hand throttle wire housing is clamped securely at bracket.
3. Push hand throttle completely in, then loosen trunnion screw and move wire trunnion to make light contact with hand throttle lever. Tighten trunnion screw, then check operation of hand throttle. If properly adjusted initial movement of hand throttle control handle will cause increase in engine speed; and when handle is pushed in, engine will return to idle speed.

FUEL FILTERS

The disposable-element type filter is contained within a threaded filter body located on a frame side rail between the fuel tank and fuel pump (refer to fig. 3). Replace element at 12,000-mile intervals. To replace element, turn the threaded filter body from frame rail mounting. Replace element and gasket.

NOTE: After replacing filter element, start engine and check for fuel leaks.

FUEL PUMP

Fuel pumps (fig. 4) used on gasoline engines covered by this manual cannot be overhauled. In the event of failure the entire pump must be replaced.

Pumps are diaphragm type, operated from an eccentric on the engine camshaft. The diaphragm is made from a single layer of fabric treated to make it impervious to gasoline and engine oil.

FUEL PUMP OPERATION

In operation, the diaphragm is pulled against pressure of spring as rocker arm is moved by engine camshaft. The partial vacuum caused in pump chamber draws fuel from tank into pump chamber through inlet valve. As camshaft rotates, pressure on rocker arm is relieved and diaphragm spring acts on diaphragm which in turn forces fuel out of pump chamber through outlet valve and through fuel line to carburetor. Each revolution of camshaft repeats this cycle, drawing fuel from tank and discharging it through line to carburetor.

When float rises in carburetor bowl and closes valve so no more fuel can enter carburetor, fuel cannot escape from fuel chamber in pump and diaphragm spring is held in compressed position. Rocker arm then idles on camshaft eccentric and diaphragm moves only a few thousandths of an inch to replace fuel which enters carburetor between pump strokes. Thus a constant pressure proportional to force of diaphragm spring is maintained on fuel in line to carburetor.

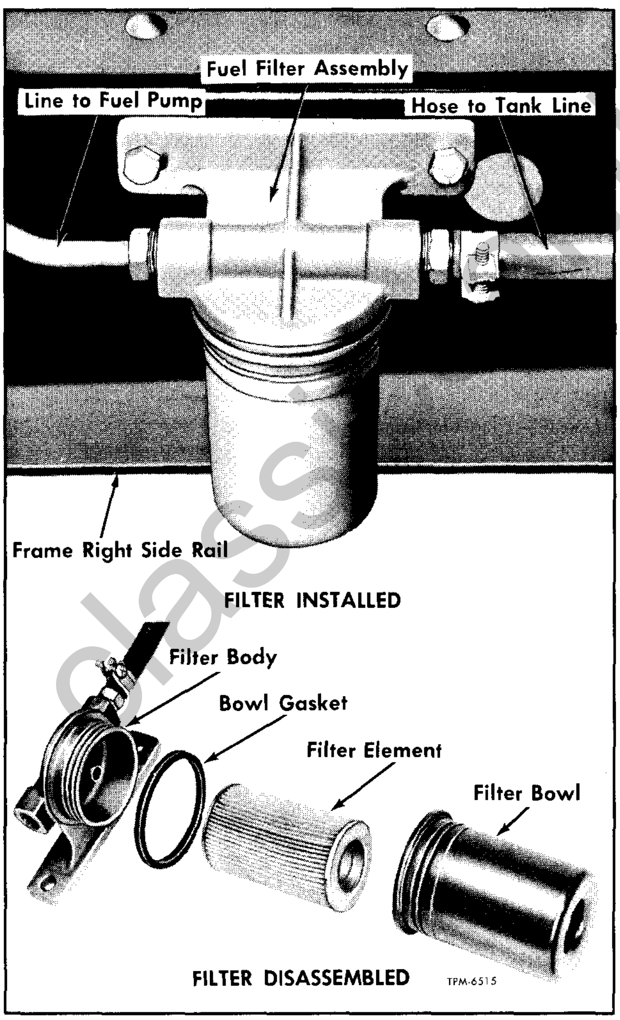


Figure 3—Frame Mounted Fuel Filter

TESTING FUEL PUMP

Always check fuel pump while it is mounted on the engine and be sure there is gasoline in the tank.

The line from tank to pump is the suction side of system. The line from pump to carburetor is the pressure side of system. A leak on the pressure side of the system would be visible because of dripping fuel. A leak on the suction side would not be apparent except for its effect of reducing the volume of fuel on the pressure side.

Tighten any loose line connections and look for bends or kinks in lines which could reduce flow of fuel.

PRESSURE TESTING

To make the pressure test, disconnect fuel line at the carburetor inlet and attach a pressure gauge between the carburetor inlet and the disconnected fuel line. Take the pressure reading with the engine runnning. The pressure should be within the limits given in "Specifications" for the particular engine. The pressure should remain constant and return to zero when the engine is stopped.

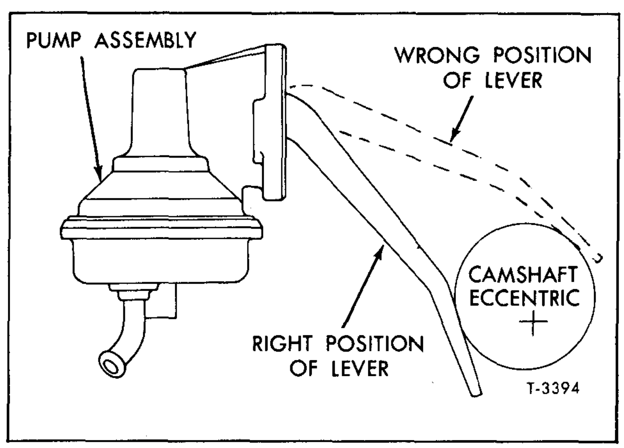


Figure 4—Fuel Pump Installation (V6 Engine)

CAPACITY TEST

To make the capacity test, connect a hose to the disconnected fuel line at the carburetor inlet. Place the hose in a pint measure held at carburetor level. Run the engine at 1200 rpm's and note the time it takes to fill the pint measure. Refer to "Specifications" for time required for type engine used.

FUEL PUMP REPLACEMENT

REMOVAL

NOTE: On trucks equipped with a shut-off valve in fuel line, close valve before removing fuel pump. Remove any accessories and piping which would interfere with fuel pump removal.

1. Disconnect fuel lines at fuel pump.

NOTE: If tank line continues to siphon, remove filler cap from fuel tank, then apply air pressure into line to force fuel back into tank. Make sure filler cap is reinstalled.

2. Remove pump mounting bolts, then move pump away from engine and remove gasket.

INSTALLATION

Before installing fuel pump, be sure mounting pad on engine is clean and that any gasket cement or portions of old gaskets have been removed.

NOTE: To facilitate installation, crank engine so eccentric on camshaft applies least tension on pump arm.

1. Place new fuel pump gasket at mounting pad on engine, then set pump in place and install mounting bolts.

IMPORTANT: When installing fuel pump, be sure pump lever is positioned as shown in figures 1 and 2, otherwise serious damage will result to the pump.

2. Connect fuel lines to pump, then open fuel shut-off valve (if used).

3. Install all accessories or piping removed to gain access for removing fuel pump.

4. Start engine and check line connections for evidence of leakage. Check pump for static pressure as explained previously.

HYDRAULIC TYPE GOVERNOR

The hydraulic type governor system consists of shaded items in figure 5. The hydraulic type governor is used as standard equipment on 401M, 478M engines.

NOTE: Key numbers in text refer to figure 6.

The hydraulic control mechanism is incorporated into the engine oil pump in engine crankcase. The spinner valve is coupled to the engine oil pump drive shaft and turns at same speed as the oil pump (½ engine crankshaft speed). At one end of the valve is a weight and at other end is a spring. The spring holds the valve assembly in closed position until such time as centrifugal force acting on valve weight begins to move the valve toward the open position. Governor valve calibration is present to provide governor action at proper speed. Engine speed control is achieved by permitting pressure from oil pump to be applied at diaphragm (5) in slave unit (fig. 6).

When accelerator pedal is depressed to wide-open position, the tension spring (3) in slave unit causes the throttle plates (10) to move to wide-open position. Diaphragm spring (4) holds diaphragm (5) in its outer position and telescopic link (7) is shortened as lever (8) on throttle shaft (9) moves and forces link into engagement with diaphragm assembly. As engine approaches governed speed the spinner valve begins to open and hydraulic pressure is applied to diaphragm (5) in slave unit. As pressure moves diaphragm, force is transmitted through link (7) to the lever (8) on throttle shaft (9) and throttle plates (10) are moved toward closed position, thereby governing the engine speed.

If engine speed falls below governed speed, the spring at spinner valve (fig. 5) closes valve and cuts off hydraulic pressure to governor line. With valve closed, line pressure is relieved through slot in side of spinner valve. Bleed hole in valve housing provides correct pressure regulation at diaphragm in slave units. Springs (3 and 4) force diaphragm back to outer position and tension spring (3) returns throttle plates to open position.

When pedal is released, the throttle driver assembly (12) engages throttle shaft driver (2) and moves throttle plates (10) to closed position.

The internal passage, between governor slave unit and air horn, insures clean air in governor housing as breathing occurs during diaphragm action. Vent also prevents any suction build-up due to vacuum transmitted through carburetor bodies.

Engine speed at which governor system begins to close throttle plates is controlled by tension of spinner valve spring.

BENDIX-STROMBERG CARBURETORS

Carburetors described in this section are used on vehicles equipped with 401M, 478M engines. The type carburetor used on these engines is the Bendix-Stromberg (WWC) carburetor.

These carburetors are of the down-draft double barrel type. Each barrel of the carburetor has its own idle system, main metering system and throttle valve. The idle and main metering systems are supplemented by the float system, the accelerating system, and the power system.

These carburetors are equipped with a manual-type choke control on all models, covered previously in this section. The choke lever is connected to the throttle linkage to provide fast idle speed position during the choke period.

In addition, all carburetors used on models covered by this manual are equipped with a hydraulically operated governor. The governor slave unit is built into the carburetor throttle body. For details refer to "Hydraulic Type Governor" covered earlier in this section.

IDENTIFICATION

Each carburetor has an identification part number tag on the air horn cover, next to the fuel inlet, as shown in figure 7. Before attempting to repair a carburetor, refer to the identification number and secure the correct repair kit.

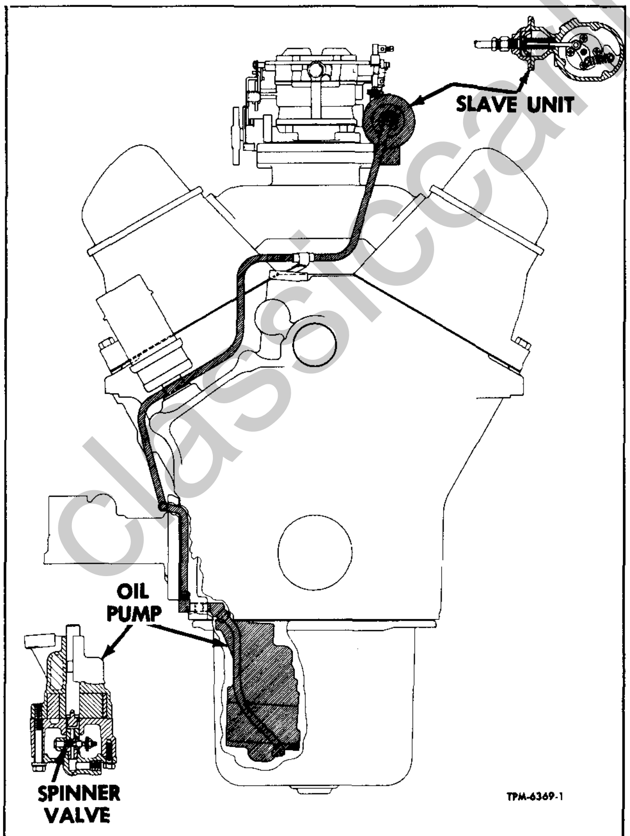
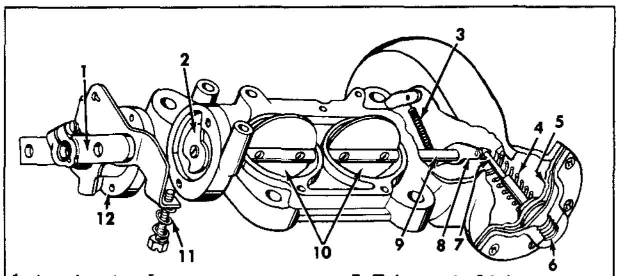


Figure 5—Hydraulic Governor System



1 Accelerator Lever
2 Throttle Shaft Driver
3 Governor Tension Spring
4 Diaphragm Spring
5 Diaphragm Assembly
6 Hydraulic Line Connection (From Spinner Valve)
7 Telescopic Link
8 Lever
9 Throttle Shaft
10 Throttle Plates
11 Fast Idle Screw
12 Throttle Driver Assembly

T-2871

Figure 6 —Governor and Throttle Operation

TROUBLE DIAGNOSIS

NOTE: The following information is included to serve as a guide in servicing carburetor. Many times a carburetor has been overhauled and replaced, yet the adverse condition still existed. Use this information which may assist in isolating the precise problem.

Before condemning the carburetor as the source of the engine running problem, always FIRST check the following:

1. Ignition System - Are the points, condenser, wires, spark plugs, and distributor operating to specifications.
2. Valve lash and spark plug gap.
3. Engine compression.
4. Crankcase ventilation and Exhaust Emission Control System (if used).
5. Fuel pump flow and pressure.
6. Intake manifold - cracks or gasket leakage.
7. Contaminate fuel.
8. Spark and valve timing.
9. Contaminated fuel filter.

When the carburetor is isolated to be the source of the problem (above items all checked and are to specifications), select one of the ten complaints shown in "Troubleshooting Chart" that best describes the problem, then proceed with the action outlined.

CARBURETOR CHECKS

It is very seldom necessary to replace a complete carburetor. They can generally be repaired at a lower cost than the price of a new assembly. Repair kits are readily available.

Although there may be exceptions, carburetors should not be replaced for the following reasons:

1. Flooding - In practically all cases, flooding is caused by a dirty or sticking float needle and

BENDIX-STROMBERG CARBURETOR TROUBLESHOOTING CHART

Locate the complaint by reading across the top of the complaint columns, then find Step 1. If Step 1 does not remedy the complaint, move to Step 2 in that column. Take Steps 3, 4, 5, etc., in order until you have located the trouble.

★ Indicate other possible trouble points.

COMPLAINT											
Flooding	Rough Idle	Economy	Hesitation	Acceleration Flatness	Surge	Low Top Speed or Power	Cold Operation	Stalling	Hard Hot Starting	CHECK POINTS	WHAT TO LOOK FOR
	1	★		★			★	1	★	Idle Adjustment	Correct speed and mixture
3		3		★	2	3		3	2	Float Adjustment	Use gauge and set to specifications
			1	★			★			Pump Adjustment	Use correct dimension, throttle valves closed
	★	★							1	Idle Vent Adjustment	Dirt, wear, sticking open; must be closed except at idle
							1	★		Choke Adjustment	Use correct gauge, fast idle screw on 2nd step of cam, next to high step
							2	★		Fast Idle Adjustment	Set with warm engine, use tachometer, set to information specification
								2		Throttle Return Check	Proper clearance with throttle lever,
		1		1	5	2				Power Piston	Bent or sticking, distorted spring
		2		2	4	1	★			Power Valve	Dirty, sticking, loose, incorrect part
		4		3	1	4	★			Metering Jets	Loose, plugged, incorrect part
1	★	★				5		5	3	Needle and Seat	Worn, damaged, dirty, loose or incorrect part
	★	★	5	4	3	★				Venturi Cluster	Dirty, loose screws, incorrect part
2		★			★			★	★	Float	Bent, leaky, distorted float arms
	3							★		Idle Needles	Worn, damaged
	4		★	★		★	★	★		Throttle Valves	Sticking open or closed, damaged, not aligned properly
4	★	★	★	★	★	★	★	4	★	Gaskets	Improper seal, hard or brittle material, loose screws
	2							★	★	Idle Passages	Dirty or Plugged
	★	★				★	★			Power Piston Vac. Pas.	Plugged or vacuum leaks
	★	★								Pump Shaft Seal	Crack or loose fit on plunger shaft
			2				★			Pump Plunger	Hard or worn leather, distorted spring, stuck vent ball check
			3				★			Pump Inlet Check Ball	Out-of-round, damaged seat, stuck
	★		4				★	★	★	Pump Discharge Check	Out-of-round, damaged seat, stuck, distorted spring
		★		★			3	★	★	Choke Valve	Dirty, damaged, sticking

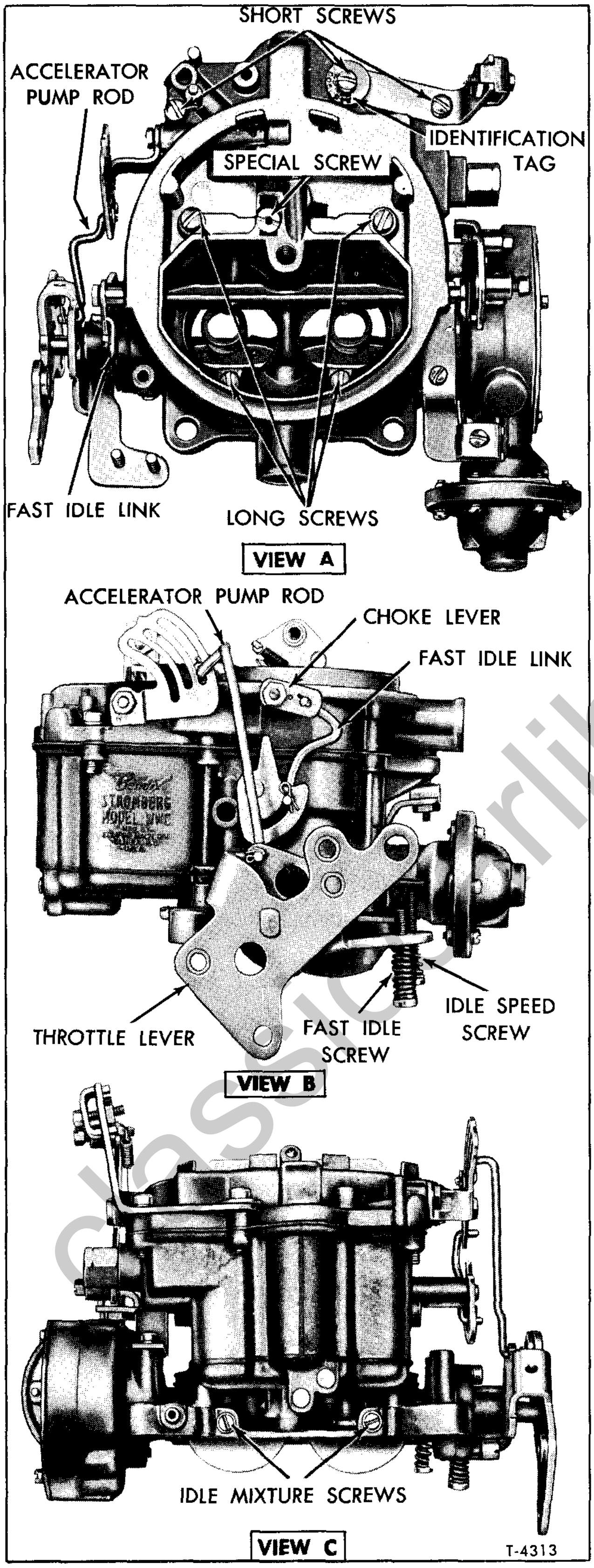


Figure 7—Bendix-Stromberg Carburetor (WWC Series)

seat. This item is easily repaired and is not a valid reason for replacing a carburetor.

2. Carburetor Spitback - Carburetors are not to be replaced as a cure for "carburetor spitback." This condition, in most cases, is not the fault of the carburetor but results from inoperative positive crankcase ventilation, incorrect valve lash, or incorrect spark plug application and/or gap setting.

Spitback on acceleration may be caused by the accelerator pump inlet ball check valve not properly seating. However, in no case should the carburetor be replaced to cure spitback.

3. Leaking - If leaking is due to a faulty carburetor, such as one with a porous casting, the leak will show up at very early mileage (0-5,000 miles). Low mileage leaking due to a porous housing is a valid reason for carburetor replacement or repair, whichever is less costly. However, higher mileage leaking (over 5,000 miles) in most cases is not caused by defective material in the carburetor.

NOTE: Fuel seepage at the bowl to air horn mating surface is normal. This usually shows up as a discolored carburetor and is caused by wicking of the gasket in the area. Correction involves a periodic tightening of the bowl to air horn assembly screws.

4. Lack of Power - Lack of engine power that is isolated to the carburetor can usually be corrected by proper carburetor calibration and adjustment. Carburetors should be repaired rather than replaced when a lack of power complaint is encountered.

BENDIX-STROMBERG CARBURETOR ADJUSTMENTS

Correct adjustment of idle spedd, ignition timing, and fuel mixture are extremely important to ensure proper operation of the system and for maximum engine performance. A tachometer is necessary for making the settings as a specific engine rpm is necessary to obtain correct adjustments.

Refer to "Engine Tune-up Specifications" in GASOLINE ENGINES (SEC. 6A) of this manual for complete tune-up specifications.

PRELIMINARY CHECKS

1. Thoroughly warm-up the engine. If the engine is cold, allow to run for at least 15 minutes.

2. Be sure the carburetor is properly secured to the intake manifold, which will exclude the possibility of air leaks.

3. Inspect the manifold heat control valve (if used) for freedom of action and correct spring tension.

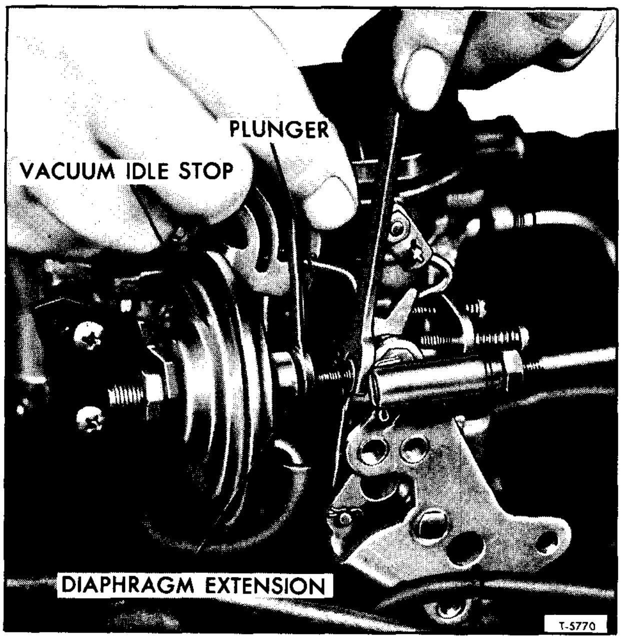


Figure 8—Adjusting Vacuum Idle Stop

IDLE AND MIXTURE ADJUSTMENT

The idle and mixture adjustments should be performed with the engine at operating temperature, and choke open.

Air conditioning when used must be turned on during the carburetor adjustments.

All V6 Engines

1. Check the dwell reading. The dwell reading on all V6 engines should be 31 to 34 degrees.
2. Set the ignition timing to 10° BUDC with vacuum advance disconnected and plugged, then reconnect vacuum advance line.
3. Disconnect and plug vacuum line to vacuum idle stop (fig. 13).

NOTE: Detailed explanation of vacuum idle stop is given later in this section under "Controlled Combustion System-Modified."

4. With engine running, vacuum idle stop disconnected, check reduced engine rpm. The reduced engine speed should be 350 rpm. If necessary, re-adjust the idle speed screw (fig. 12) to obtain 350 rpm.
5. Connect vacuum line from carburetor to vacuum idle stop. With engine running, vacuum idle stop connected, engine idle speed should be 550 rpm. If necessary to readjust idle speed perform the following:

a. Referring to figure 8, place a 1/4-inch open end wrench on diaphragm extension of vacuum idle stop to prevent its rotation while adjusting plunger.

CAUTION: UNDER NO CONDITIONS SHOULD THE DIAPHRAGM EXTENSION BE ALLOWED TO ROTATE OR INTERNAL DAMAGE WILL RESULT TO VACUUM IDLE STOP UNIT.

b. Adjust the plunger with a 3/8-inch open end wrench until the face of the plunger hex contacting the carburetor throttle lever results in an idle speed of 550 rpm.

6. Adjust the idle mixture screws (fig. 7). With engine running and idling speed set, turn each mixture screw "in" until engine begins to slow down or run unevenly, then back out screws until engine runs smoothly with highest vacuum gauge reading.

NOTE: If vacuum gauge is not available adjust idle mixture screws to give highest idle speed. Turning idle mixture screws "in" gives leaner mixture; while turning screws "out" gives richer mixture. DO NOT turn screws in tight against seats since screws or seats will be damaged.

7. Reset the engine idle speed to 575 rpm, by adjusting plunger on vacuum idle stop as previously described.
8. Turn "in" idle mixture screws (lean mixture) equally to reduce idle speed to 550 rpm.

Fast Idle Adjustment (All Engines)

The fast idle mechanism is used to provide increased engine speed when choke valve is not fully open. Fast idle screw is shown in figure 7. The link installed between choke valve lever and

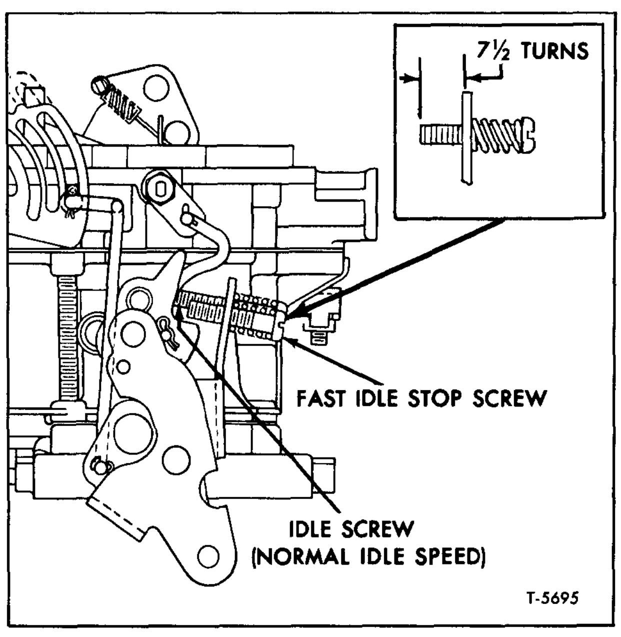


Figure 9—Fast Idle Adjustment

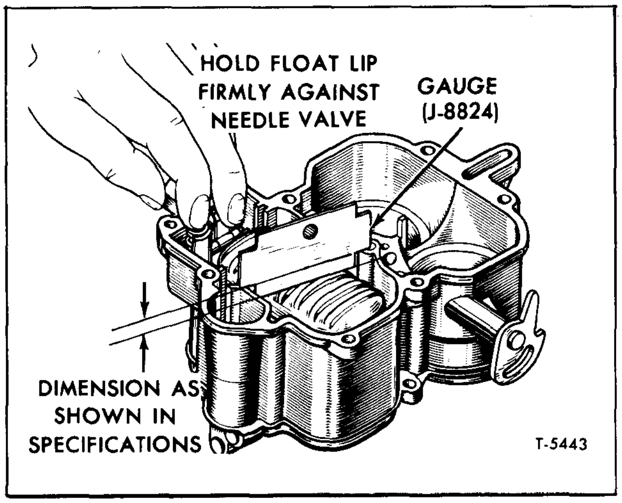


Figure 10—Checking Float Level

fast idle cam operates cam when choke valve is closed.

Check the position of cam with choke valve fully open. Fast idle screw must clear cam when throttle is at idle position. If there is interference, bend link to allow fast idle cam to drop below fast idle screw with throttle plate closed and choke open. To adjust fast idle properly, locate end of fast idle screw flush with inner surface of lever, then turn screw "in" 7½ turns, as shown in figure 9.

FLOAT LEVEL ADJUSTMENT

Remove air cleaner and disconnect choke wire from choke lever. Disconnect fast idle link and accelerating pump rod. Remove three short screws attaching air horn to main body, then remove one long screw at forward side of air horn and one long screw next to fuel body. Replace these screws with two of the short screws to hold main body flange to throttle body. Tighten securely. Remove balance of air horn to main body screws, then remove air horn.

Use float gauge (J-8824) to check relationship of the float to the top of the fuel bowl as typically shown in figure 10. The gauge has several steps for use with various carburetors. Refer to "Specifications" for the proper float level adjustment dimension. Hold the tab on the float firmly against needle valve when using the gauge, Setting is correct when the edge of the gauge touches top of the rib on the float. Use tool (J-4395) to bend float

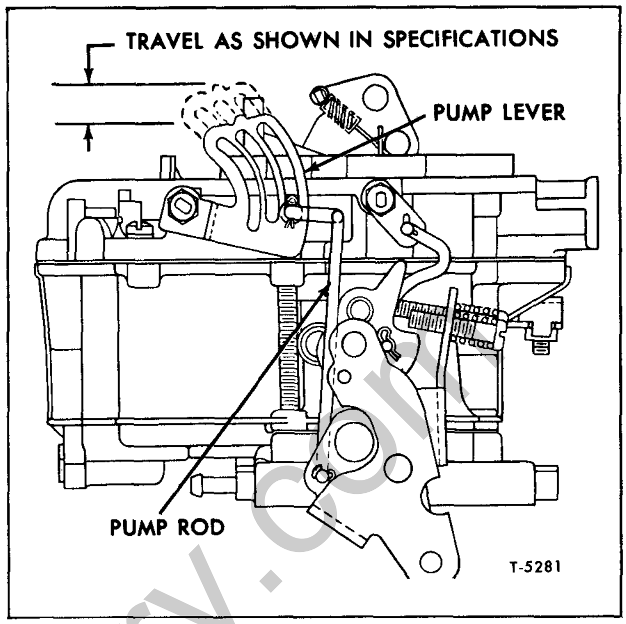


Figure 12—Accelerator Pump Adjustment

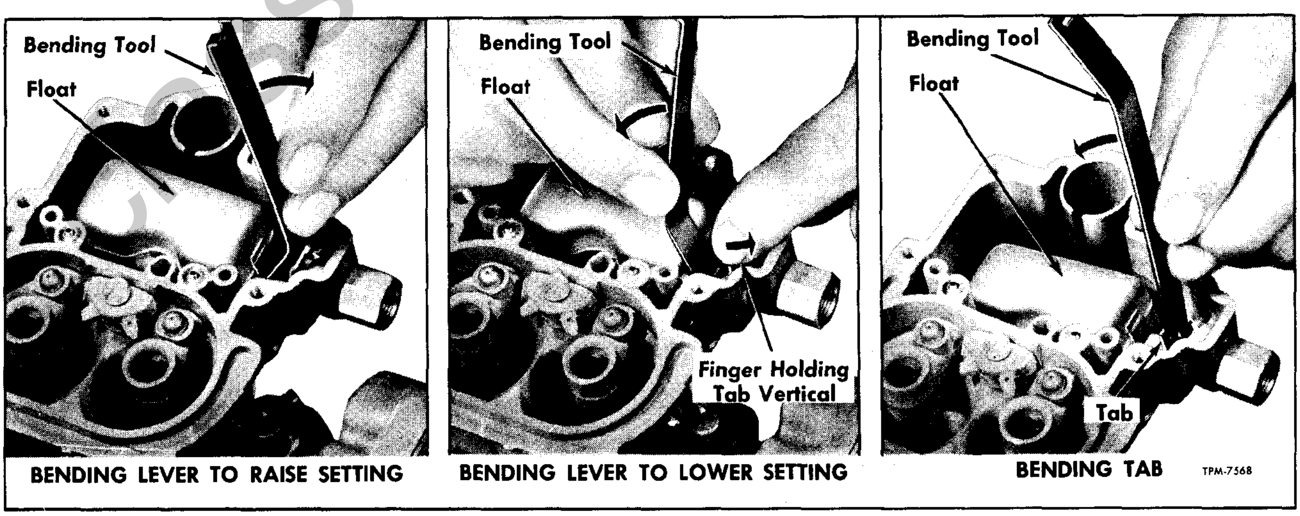


Figure 11 —Typical Use of Bending Tool to Set Float Level

lever next to float to change the float setting. Use bending tool as illustrated in figure 11.

After checking the float level, install air horn and a new gasket. Locate screws, choke control bracket, and identification tag in original positions. Connect fast idle link, accelerating pump rod, and choke wire. Install air cleaner.

ACCELERATOR PUMP TRAVEL ADJUSTMENT

Measure the total distance from the point at top of pump lever travel when throttle lever is moved from closed to wide open position as shown in figure 12. The pump travel is as indicated in "Specifications." When necessary to adjust the lever travel, bend the pump rod at the upper end.

EXHAUST EMISSION CONTROL SYSTEMS

Since products of combustion in gasoline engines contain contaminants which cause atmospheric pollution, a means to reduce harmful emissions must be employed. Devices used for this purpose fall into one of the following categories:

1. Positive Crankcase Ventilation System (P.C.V.).
2. Controlled Combustion System - Modified (C.C.S.-M.).

The first system serves to prevent air pollution by re-cycling fumes from the crankcase (used on all engines). The other system is used for control of air pollution from exhaust system. All gasoline engines covered by this manual, are equipped with C.C.S.-M.

POSITIVE CRANKCASE VENTILATION SYSTEMS

For detailed information on Crankcase Ventilation Systems, refer to GASOLINE ENGINES (SEC. 6A) of this manual.

CONTROLLED COMBUSTION SYSTEM MODIFIED (C.C.S.-M.)

The C.C.S.-M. system is that system which increases combustion efficiency, and combustion efficiency reduces the hydrocarbon and carbon monoxide emissions. The complete effectiveness of this system, as well as full power and performance, is dependent upon the correct idle speed, ignition timing, and idle fuel mixture.

IMPORTANT: The C.C.S.-M. system consists of no additional components, other than a specially calibrated carburetor and a vacuum idle stop.

CARBURETOR

The carburetor used on C.C.S.-M. equipped vehicles functions and operates the same as all other Bendix-Stromberg carburetors used on V6 engines. But under no circumstances should they be interchanged with, or replaced by another type carburetor.

NOTE: For carburetor adjustments on C.C.S. -M. engines, refer to "Idle and Mixture Adjustments" previously covered in this section.

VACUUM IDLE STOP (Refer to Fig. 13)

A vacuum idle stop unit is used on all C.C.S. -M. equipped engines to prevent engine "dieseling" (engine operation after ignition switch is turned off).

The idle stop unit is mounted to the carburetor with a bracket and acts upon the throttle plates of the carburetor in the same manner as an idle setscrew. When the engine is started, engine vacuum acts upon the diaphragm in the idle stop unit and the plunger is pushed to its full extended position. The plunger acts upon the throttle lever and sets the throttle plates in a position to achieve the specified idle rpm. When the ignition switch is turned "OFF," engine vacuum is reduced and the plunger retracts into the idle stop unit. The result is the throttle plate closes to a lower position

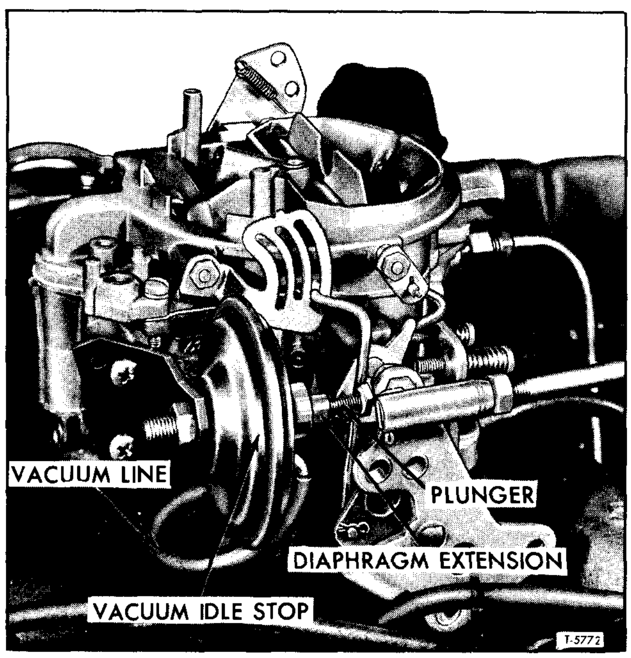


Figure 13—Vacuum Idle Stop Installation

which is controlled by the idle speedscrew. At this point, the throttle plate is open only enough to allow the engine to run well below normal idle rpm.

NOTE: For adjustment of the vacuum idle stop, refer to "Idle and Mixture Adjustment" previously covered in this section.

SPECIFICATIONS

BENDIX-STROMBERG CARBURETOR MODEL APPLICATION

TRUCK SERIES	ENGINE	GM PART NO.	VENDOR NO.	CODE NO.
HM, JM 80	401M	663240	381274	23-232
TM 80	401M	663242	381275	23-233
OPTIONAL				
HM, JM 80	478M	663240	381274	23-232
TM 80	478M	663242	381275	23-233

BENDIX-STROMBERG CARBURETOR SPECIFICATIONS

GM PART NO.	663240 663242 663244	2492166
Venturi Size	$1\frac{5}{16}$	$1\frac{15}{32}$
Main Metering Jet Size	0.065	0.075
High Speed Bleeder No.	No. 68	No. 68
Power By-Pass Jet	1 No. 53	2 No. 55
Accelerating Pump Discharge Jet No.	70	70
Idle Discharge Holes:		
Primary No.	50	52
Secondary No.	60	None
Tertiary No.	56	None
Idle Tube Feed Hole No.	64	68
Idle Air Bleed Cluster No.	55	51
Vacuum Spark Hole	2 No. 65	2 No. 65
Float Needle Valve Seat	0.113	0.113
Governor Diaphragm Spring No.	389702	389702
Governor Throttle Spring No.	389703	389703
Throttle Spring Anchor Position	No. 3	No. 3
Discharge Nozzle No.	28	28
Nozzle Tip to Wall:		
Left	0.400	0.250
Right	0.400	0.250
Float Level	$\frac{5}{32}$	$\frac{5}{32}$
Accelerator Pump Travel	.0190	0.190

FUEL PUMP SPECIFICATIONS

ENGINE	PUMP MODEL	P.S.I. PRESSURE	VOLUME
V6	6440050	5-6½*	1 pint in 20-25 seconds

*At 16" above outlet.
**At outlet.

HYDRAULIC-TYPE GOVERNOR

Spinner Valve		Engine Governed Speed (Full Load)	
Location	At Engine Oil Pump	401-M Engine	3400 RPM
Type	Centrifugal, Pre-set	478-M Engine	3200 RPM
Slave Unit		Note: Refer to GASOLINE ENGINES (sec. 6A) for spinner valve adjustment procedure.	
Location	Carburetor Throttle Body		

53 AND 71 SERIES DIESEL ENGINES

Contents of this section are listed in Index below:

FUEL FILTERS

Fuel filter elements on these engines should be replaced at regular intervals established by the operator. Element replacement intervals are dependent on the cleanliness of the fuel and on storage facilities.

IMPORTANT: Neglect of fuel filters can lead to eventual damage to certain fuel system components.

PRIMARY FILTER

Primary fuel filter (fig. 1) is bracket-mounted at frame side rail, or on some vehicles on engine.

Primary fuel filter, Stamped T-74, is connected in line between fuel tank and fuel pump.

Filter element is noncleanable type and should be replaced at 5,000 to 10,000 mile intervals. A drain cock at bottom of filter should be opened daily and a small amount of fuel should be drained. Observe fuel drained for presence of water. If water is indicated regularly, the fuel tank and lines should be drained and cleaned.

Element replacement procedure is same as for secondary filter which follows:

SECONDARY FILTER

Secondary filter is disposable-element type and is bracket-mounted on engine as typically illustrated in figure 2.

Secondary fuel filter, Stamped T-65, is located between supply pump and injectors.

At regular intervals, depending upon operating experience, drain a small amount of fuel from filter and observe for presence of water or other foreign matter.

Regular element replacement interval is 20,000 to 25,000 miles or six months, whichever occurs first.

Although the elements used in primary and secondary filters (figs. 3 and 4) are of different design, the element replacement procedure is the same for both filters. The filter elements are not cleanable.

1. Remove drain plug or open drain cock to drain the filter.
2. Loosen bolt at top of filter until shell and element can be removed.
3. Lift element from shell and discard.
4. Wash all parts with a suitable solvent to remove all accumulated foreign matter.
5. Install new element in shell, fill with clean fuel, then position element and shell assembly to base using gaskets furnished with new element.
6. Tighten cap screw securing shell in place. Check filter connections and fuel lines for leaks and tighten if necessary.

For service of fuel lines refer to FUEL TANK AND EXHAUST (SEC. 8) of this manual.

Figure 1—Primary Fuel Filter

Figure 2—Secondary Fuel Filter

ACCELERATOR AND THROTTLE LINKAGE ADJUSTMENT

CONVENTIONAL CAB MODELS

6V-53, 6-71 AND 8V-71 DIESEL ENGINES

NOTE: Refer to figure 5 or 6.

1. Disconnect pull-back spring. Disconnect accelerator rod assembly at cross shaft lever on 6-71 and 6V-53 engines and at governor lever on 8V-71 engine.

2. Block accelerator pedal down firmly against floor mat.

3. Hold governor lever in full throttle position and adjust length of accelerator rod assembly until end of rod assembly fits freely into cross shaft lever of 6-71 or 6V-53 engine or into governor lever of 8V-71 engine.

4. Connect rod assembly and release accelerator pedal. Connect pull-back spring.

STEEL TILT CAB MODELS

(Refer to Figure 7)

With accelerator controls installed, make the following checks:

(a) Thread of rod end assembly "D" engaged ½".

(b) Governor lever "C" properly installed.

1. Depress and hold the accelerator pedal "A," ¼-inch from floor mat.

2. Adjust rear rod assembly "B" to obtain full throttle at governor lever "C."

3. In some cases it may be necessary to adjust rod end assembly "D" in front.

ALUMINUM TILT CAB MODELS

(Refer to Figure 8)

The cab mounted components of the accelerator control mechanism are identical with either

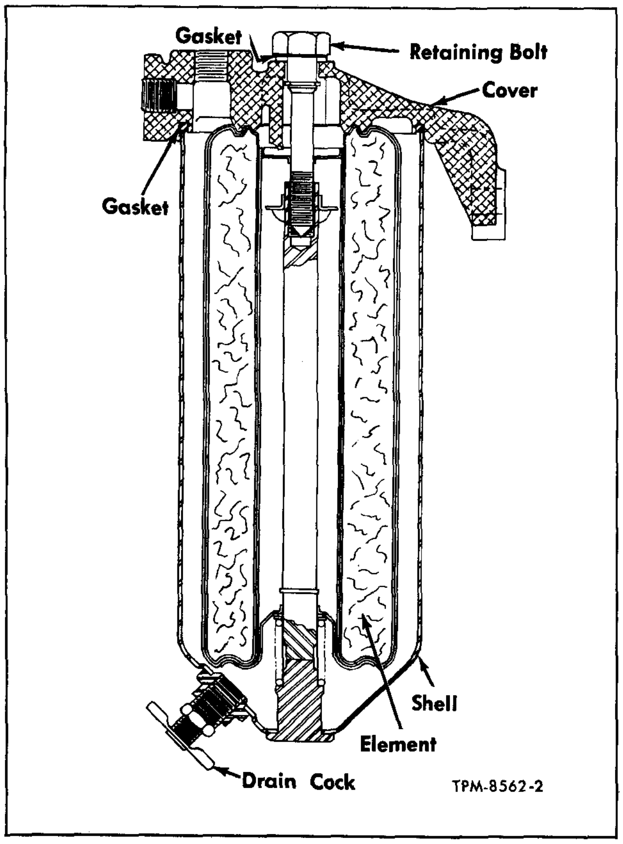


Figure 3—Sectional View of Primary Fuel Filter

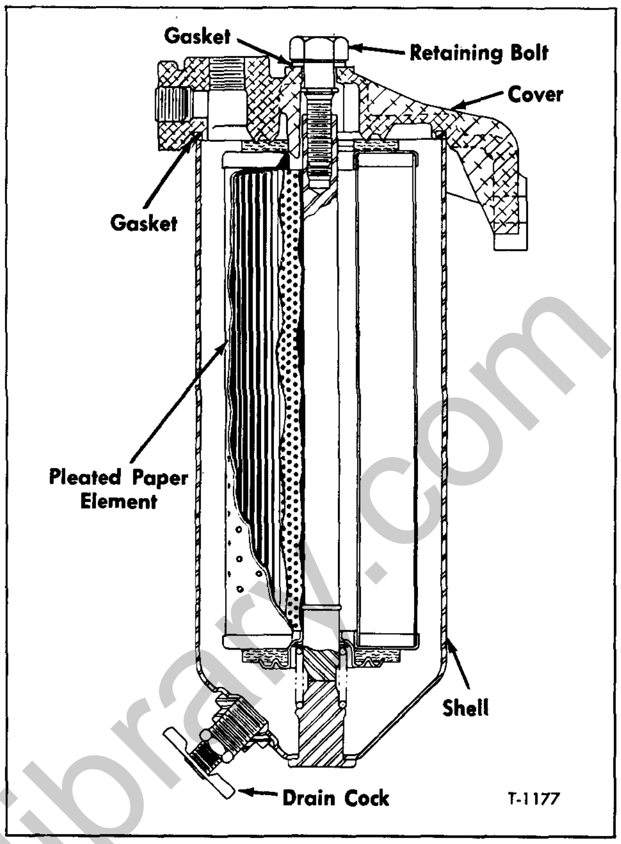


Figure 4—Sectional View of Secondary Fuel Filter

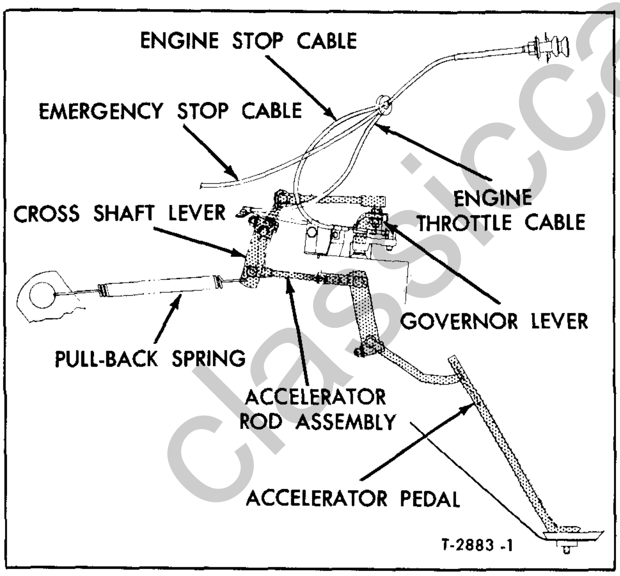


Figure 5—Accelerator Linkage for 6V53 Diesel Engine (Conventional Cab Models) (Typical)

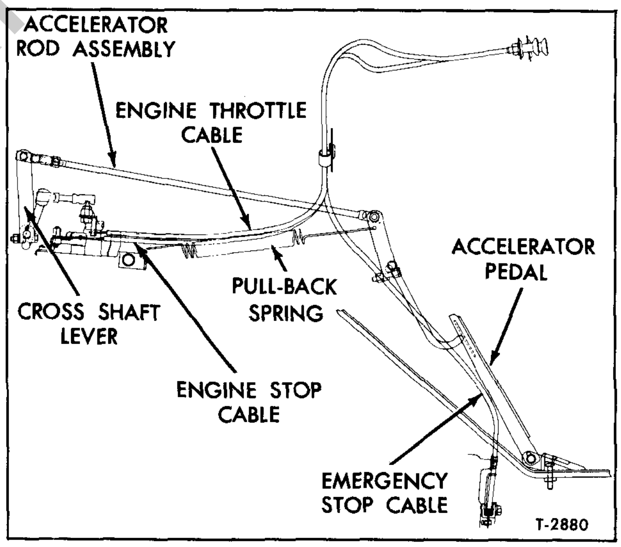


Figure 6—Accelerator Linkage for 6-71 or 8V-71 Diesel Engines (Conventional Cab Models) (Typical)

V8 or In-Line diesel powered vehicles covered in this manual, however, the engine mounted components differ, according to engine type. To adjust the linkage on all vehicles, refer to figure 8 and the following instructions:

NOTE: Hand throttle must be in "OFF" position.

1. With the cab in the driving position, loosen bracket assembly "A" attaching bolts, then slide

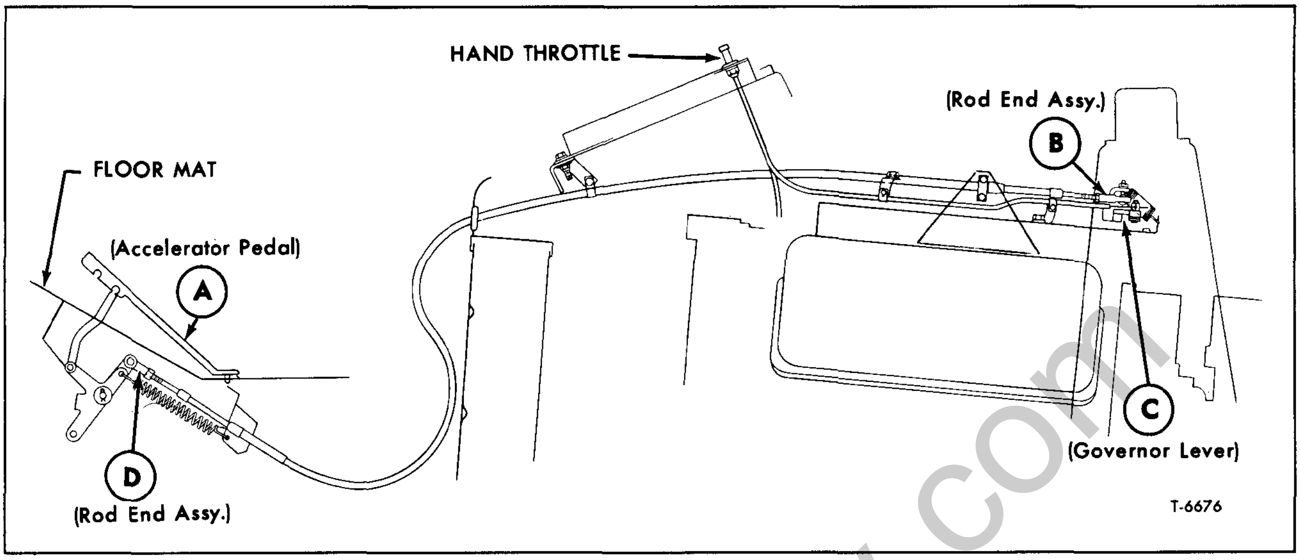


Figure 7—Flexible Accelerator Cable (Steel Tilt Cab Models)

bracket to obtain 1/8-inch clearance between lever "B" and roller "C." Torque attaching bolts to 5 to 8 foot-pounds.

2. Rotate lever assembly "B" to full throttle position and adjust stop bolt "D" to contact accelerator. Tighten stop bolt jam nut "E."

> NOTE: When assembling accelerator control cross shaft arm to governor arm linkage, note that two holes exist in the cross shaft arm; each hole is identified by a stamped "D" or "F." Connect the linkage to the "D" hole on DH or DI Models, or to the "F" hole on FH or FI Models. This is necessary to compensate for the different engine to chassis mounting angles.

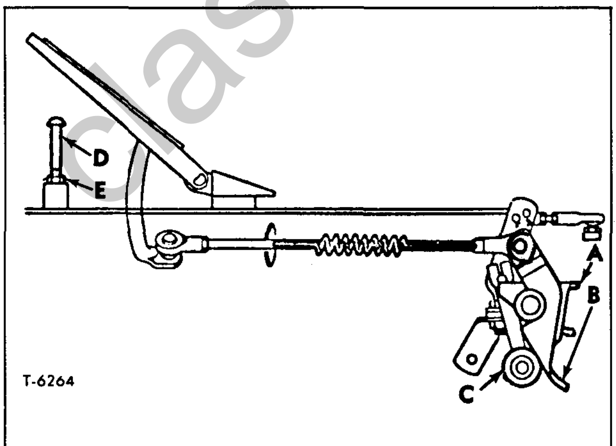


Figure 8—Accelerator Control Adjustment

HAND THROTTLE ADJUSTMENT (ALL MODELS)

The hand throttle is operated by a flexible wire cable, mounted on the gearshift control pedestal. Engine speed is increased as the knob is pulled upward and may be locked in place at any desired speed by turning knob until locking device is engaged. To release the throttle from the locked position, turn the knob one-quarter turn in either direction and push the knob all the way down to return the engine speed to a normal idle. Adjusting the throttle may be accomplished by the following:

1. Check the accelerator linkage for free movement and be sure that the return spring moves the linkage to idle position.
2. Tilt the cab forward, then follow the cable routing from the gearshift control pedestal to the throttle actuating arm on the accelerator cross shaft. Inspect the housing for kinks or damaged areas. If badly kinked or damaged, replace the cable.
3. Check to see that the cable housing is clamped securely at the support bracket.
4. Push the knob all the way in and loosen the screw attaching the trunnion to the wire.
5. Position the trunnion on the wire with 1/8-inch clearance between the trunnion and actuating lever (see fig. 9). Tighten the trunnion screw.

ENGINE NORMAL STOP CONTROL ADJUSTMENT (ALL MODELS)

The engine stop control is operated by a flexible wire cable located on the shift control pedestal.

The function of the engine stop is to position the governor to a no-fuel position. Perform the following instructions to adjust the engine stop.

1. Inspect the cable for proper routing and general condition. If the cable is kinked or damaged, replace.

2. Push the control knob downward to end of travel, then loosen trunnion-to-wire screw. Push governor stop lever to the extreme run position.

3. Pull control knob out 1/8-inch, then holding governor stop lever in the extreme run position, tighten the trunnion-to-wire attaching screw.

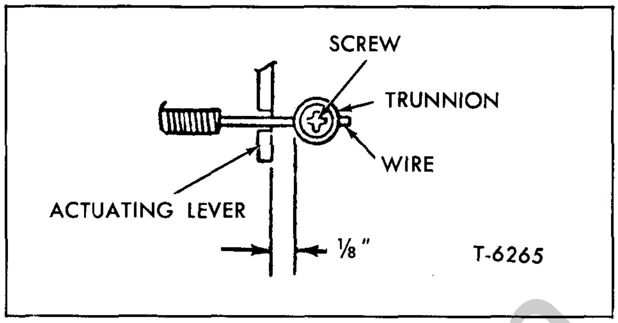


Figure 9—Control Cable Trunnion Installation

EMERGENCY STOP ADJUSTMENT (ALL MODELS)

The emergency stop is operated by a flexible wire control cable and is to be used only if the regular stop procedure fails. When the emergency stop is pulled, a spring-loaded latch is released which allows a spring-loaded blower choke valve to close. This action blocks off engine air. Once pulled, the emergency stop must be manually reset. Adjust the emergency stop cable as instructed.

1. Tilt the cab, or raise hood forward, then inspect the general condition of the cable. If kinked or damaged, replace.

2. With the emergency stop in the "set" (normal) position and the knob pushed all the way down, loosen the trunnion-to-wire attaching screw and move the trunnion so that 1/8-inch of "free play" exists between trunnion and spring-loaded operating latch (see fig. 2).

3. Operate the emergency stop without engine running to check the operation.

CAUTION: The "Emergency Stop" is provided for emergency use only, and should not be used indiscriminately, since the high vacuum produced may eventually damage blower seals, necessitating blower overhaul.

FUEL INJECTION SYSTEM (53 AND 71 SERIES)

FUEL SYSTEM—GENERAL

The fuel system consists of the fuel primary filter, fuel pump, fuel secondary filter, fuel lines and injectors as shown in figure 10.

A 0.070" restricted fitting is located in the cylinder head fuel return manifold outlet on 6V-53 Series engines to maintain pressure within the fuel system, between the fuel pump and restricted fitting, and 0.080" on 71 Series engines.

On some models a check valve, if required, is installed in the supply line between the fuel tank and fuel primary filter, to keep the fuel oil from draining back into the fuel tank when the engine is shut down.

The fuel pump draws fuel from tank through the primary filter, and forces it under pressure through the secondary filter. From the secondary filter, the fuel is forced through the fuel inlet passage in the cylinder head and fuel lines to the injector.

The fuel passes through a filter element within the injector to a chamber where it is metered, displaced, and atomized through the spray tip into the combustion chamber.

Heat generated by the high compression of air

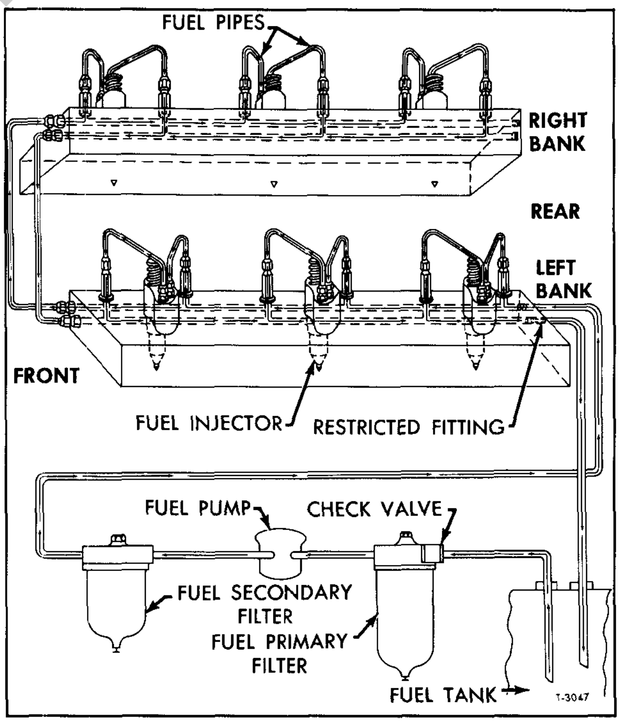


Figure 10—Fuel System (Typical for "V" Engines)

1 Follower
2 Follower Spring
3 Follower Stop Pin
4 Plunger
5 Gear
6 Gear Retainer
7 Seal Ring
8 Plunger Bushing
9 Spill Deflector
10 Check Valve
11 Valve Spring
12 Spring Seat
13 Needle Valve
14 Spray Tip
15 Spring Cage
16 Body Nut
17 Check Valve Cage
18 Dowel
19 Control Rack
20 Fuel Filter
21 Injector Body
22 Gasket
23 Filter Cap

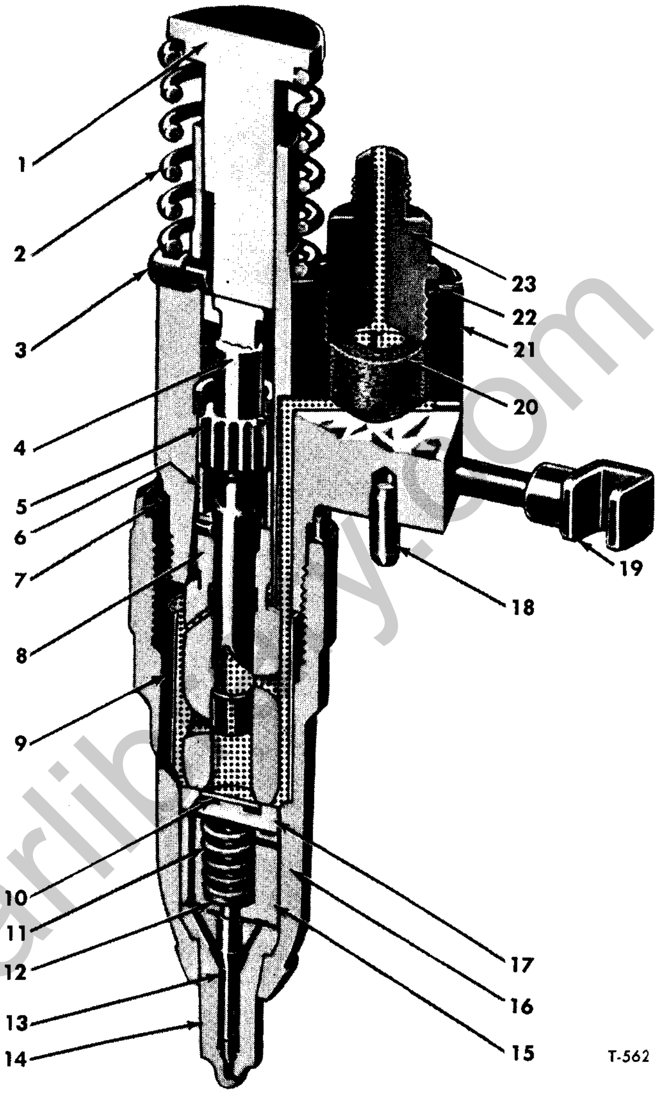


Figure 11—Fuel Injector Assembly

ignites the fine fuel spray and combustion continues until the fuel is burned.

Fuel in excess of that required for engine operation is circulated through the injectors by the fuel pump. In addition to serving as a coolant, circulation of the surplus fuel bleeds any air or vapor in the system back to the fuel tank where it is vented to the atmosphere. Surplus fuel leaving the injectors flows through the outlet fuel line to the fuel return passage, through a restricted fitting, and back to the fuel supply tank.

FUEL INJECTORS

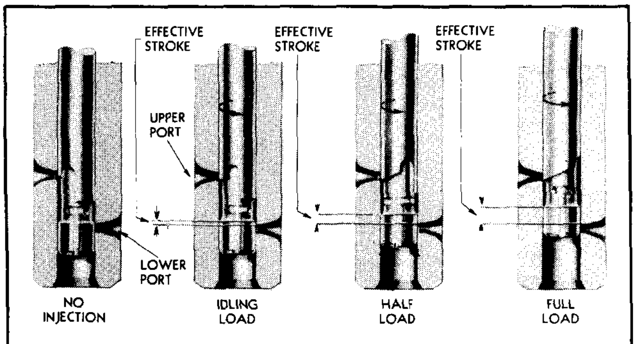
DESCRIPTION

The GM unit fuel injector illustrated in figure 11 is a lightweight compact unit which enables quick easy starting directly on diesel fuel and permits the use of a simple open type combustion chamber. The simplicity of design and operation provides for simplified controls and easy adjustment. No high pressure fuel lines or complicated air-fuel mixing or vaporizing devices are required.

The unit fuel injector performs four functions:

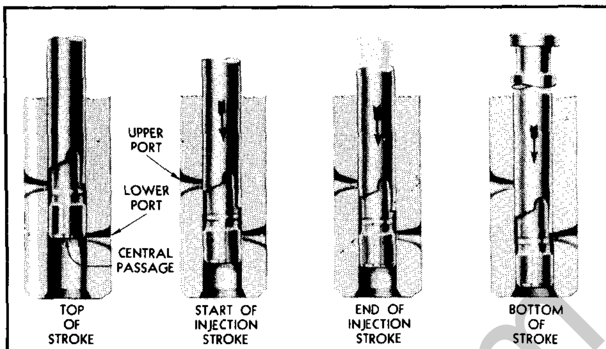
1. Creates the high fuel pressure required for efficient injection.
2. Meters and injects the fuel to the exact amount required to handle the load.
3. Atomizes the fuel for mixing with the air in the combustion chamber.
4. Permits continuous fuel flow.

Combustion required for satisfactory engine operation is obtained by injecting, under pressure, a small quantity of accurately metered and finely atomized fuel oil into the combustion chamber.



Fuel Metering From No Injection To Full Injection, Produced By Rotating Plunger with Control Rack TP 3812

Figure 12—Fuel Metering Position from No-Load to Full-Load



Phases of Injector Operation By Vertical Travel of Plunger TP 3813

Figure 13—Phases of Injector Operation Through Vertical Travel of Plunger

Metering of the fuel is accomplished by an upper and lower helix machined in the lower end of the injector plunger. Figure 12 illustrates the fuel metering from NO-LOAD to FULL-LOAD by rotation of the plunger in the bushing.

Figure 13 illustrates the phases of injector operation by the vertical travel of the injector plunger.

The continuous fuel flow through the injector serves, in addition to preventing air pockets in the fuel system, as a coolant for those injector parts subjected to high combustion temperatures.

To vary the power output of the engine, injectors having different fuel output capacities are used. The fuel output of the various injectors is governed by the helix angle of the plunger and the type of spray tip used. Refer to figure 14 for the identification of the injectors and their respective plungers and spray tips.

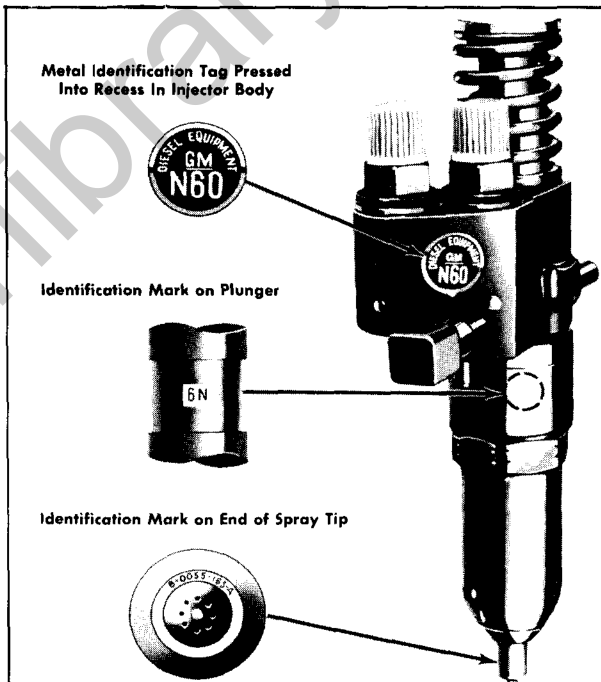
Since the helix angle on the plunger determines the output and operating characteristics of a particular type of injector, it is imperative that the correct injectors are used for each engine application. If injectors of different types are mixed, erratic operation will result and may cause serious damage to the engine and to the equipment which it drives.

CAUTION: Do not intermix the needle valve injectors with the other types of injectors in an engine.

Both the plunger and bushing are marked with corresponding numbers to identify them as mating parts. Therefore, if either the plunger or bushing requires replacement, both must be replaced as an assembly.

Each fuel injector has a circular disc pressed into a recess at the front side of the injector body for identification purposes (fig. 14). The identification tag indicates the nominal output of the injector in cubic millimeters.

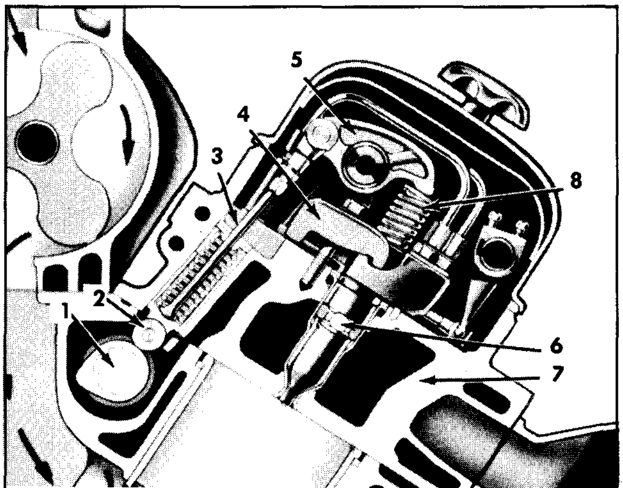
The fuel injector combines in a single unit all the parts necessary to provide complete and independent fuel injection at each cylinder.



INJECTOR	SPRAY TIP*	PLUNGER
N45	6.006 - 165A	$^{4}_{5}N$
N55	8.0055 - 165A	$^{5}_{5}N$
N60	8.0055 - 165A	6N
N65 (White Tag)	8.0055 - 165A	$^{6}_{5}N$
N65 (Brown Tag)	8.006 - 165A	N^{6}_{5}

*First numeral indicates number of spray holes, followed by size of holes and angle formed by spray from holes: T-6690

Figure 14—Injector Identification



1 Camshaft	5 Rocker Arm
2 Cam Follower Assy.	6 Injector Assy.
3 Push Rod	7 Cylinder Head
4 Hold-Down Clamp	8 Follower Spring

T-6689

Figure 15—Fuel Injector Installed (Typical "V" Engine Shown)

OPERATION

Fuel, under pressure, enters the injector at the inlet side through a filter cap and filter element (fig. 11). From the filter element, the fuel passes through a drilled passage into the supply chamber, that area between the plunger bushing and the spill deflector, in addition to that area under the injector plunger within the bushing. The plunger operates up and down in the bushing, the bore of which is open to the fuel supply in the annular chamber by two funnel-shaped ports in the plunger bushing.

The motion of the injector rocker arm is transmitted to the plunger by the follower which bears against the follower spring (fig. 15). In addition to the reciprocating motion, the plunger can be rotated, during operation, around its axis by the gear which meshes with the rack. For metering the fuel, an upper helix and a lower helix are machined in the lower part of the plunger. The relation of the helixes to the two ports changes with the rotation of the plunger (figs. 12 and 13).

As the plunger moves downward, under force of the injector rocker arm, a portion of that fuel trapped under the plunger is displaced into the supply chamber through the lower port until the port is closed off by the lower end of the plunger.

A portion of the fuel trapped below the plunger is then forced up through a central passage in the plunger into the recess and into the supply chamber through the upper port until that port is closed off by the upper helix of the plunger. With the upper and lower ports both closed off, the remaining fuel under the plunger is subjected to increased pressure by the continued downward movement of the plunger.

When sufficient pressure is built up, it opens the flat, non-return, check valve. The fuel in the check valve cage and spring cage passages, tip passages and tip fuel cavity is compressed until the force acting upward on the needle valve is sufficient to open the valve against the downward force of the valve spring. As soon as the needle valve lifts off its seat, the fuel is forced through the small orifices in the spray tip and is atomized in the combustion chamber.

When the lower land of the plunger uncovers the lower port in the bushing, the fuel pressure below the plunger is reduced, and the valve spring closes the needle valve, ending injection.

A pressure relief passage has been provided in the spring cage to permit bleed off of fuel leaking past the needle pilot in the tip assembly.

A check valve, directly below the bushing, prevents leakage from the combustion chamber into the fuel injector in case the valve is accidentally held open by a small particle of dirt. The injector plunger is then returned to its original position by the injector follower spring. Figure 13 shows the various phases of injector operation by the vertical travel of the injector plunger.

On the return upward movement of the plunger, the high pressure cylinder within the bushing is again filled with fuel oil through the ports. The constant circulation of fresh cool fuel through the injector renews the fuel supply in the chamber, helps cool the injector and, also, effectively removes all traces of air which might otherwise accumulate in the system and interfere with accurate metering of the fuel.

The fuel injector outlet opening, through which the excess fuel oil returns to the fuel return passage and then back to the fuel tank, is directly adjacent to the inlet opening and contains a filter element exactly the same as the one on the fuel inlet side.

Changing the position of the helixes, by rotating the plunger, retards or advances the closing of the ports and the beginning and ending of the injection period. At the same time, it increases or decreases the amount of fuel injected into the cylinder. Figure 12 shows the various plunger positions from NO-LOAD to FULL-LOAD. With the control rack pulled out all the way (no injection), the upper port is not closed by the helix until after the lower port is uncovered. Consequently, with the rack in this position, all of the fuel is forced back into the supply chamber and no injection of fuel takes place. With the control rack pushed in (full injection), the upper port is closed shortly after the lower port has been covered, thus producing a maximum effective stroke and maximum injection. From this no injection position to full injection position (full rack movement), the contour of the upper helix advances the closing of the ports and the beginning of injection.

The unit fuel injector is one of the most important and precisely built parts of the engine. On this unit depends the injection of the correct amount of fuel at exactly the right time into the combustion chamber. Because the injector operates against high compression in the combustion chamber, efficient operation demands that injector assemblies be maintained in first-class condition at all times. Proper maintenance of the fuel system and the use of the recommended type fuel filters and clean water-free fuel are the keys to trouble-free operation of the injectors.

SERVICING THE INJECTOR

LOCATING A MISFIRING INJECTOR

1. Start the engine and run it at part load until normal operating temperature is reached.
2. Remove valve cover.
3. Check the valve clearance. Refer to "Engine Maintenance and Tune-up" in 53 AND 71 SERIES DIESEL ENGINES (SEC. 6C) of this manual.
4. Hold an injector follower down with a screwdriver, thus preventing operation of the injector. If the cylinder has been misfiring, there will be no noticeable difference in the sound and speed of the engine. If the cylinder has been firing properly there will be a noticeable difference in the sound and operation when the follower is held down. This procedure is similar to short-circuiting a spark plug of a gasoline engine.
5. If the cylinder is firing properly, repeat the procedure on the other cylinders until the faulty one has been located.
6. If misfiring difficulty is attributed to the injector, replace injector as described later in this section.

INJECTOR REMOVAL

<u>General</u>

Servicing an injector is not a difficult task and may be performed by the average service man. However, due to the close tolerances of various injector parts, extreme cleanliness and strict adherence to service instructions is required.

When servicing injectors, the following instructions should be carefully followed:

1. When the fuel lines are removed from an injector, cover the filter caps with shipping caps to keep dirt out of the injector. Also, protect the fuel lines and fuel connectors from entry of dirt or other foreign material.
2. After the injectors have been operated in an engine, the filter caps or filters should not be removed while the injectors are in the engine. Filter elements should be replaced only at the time of complete disassembly and assembly of an injector.
3. Whenever an injector has been removed and reinstalled, or a new injector has been installed in an engine, it will be necessary to lash valves, time injectors, and position the injector rack control levers as outlined in "Engine Tune-up Operations" in 53 AND 71 SERIES DIESEL ENGINES (SEC. 6C) in this manual.
4. When a reconditioned injector is to be placed in stock, it should be filled with a quality grade of rust preventive. Injector test oil J-8130 is suitable for this purpose. Install shipping caps on both filter caps immediately after filling. Do not fill the injector with fuel oil.

NOTE: Make sure that new filters have been installed in a reconditioned injector which is to be placed in stock. This precaution will prevent dirt particles from entering the injector due to a possible reversal of fuel flow when installing the injector in an engine other than the original unit.

REMOVAL OPERATIONS

NOTE: If removing injectors on vehicles with engine brake system, refer to Section 6C for replacement of engine brake components.

If it becomes necessary to remove one or more fuel injectors for inspection or replacement, follow the procedure given below:

1. Remove the valve rocker cover(s).
2. Remove the fuel lines from both the injector and the fuel connectors (fig. 15).

NOTE: Immediately after removal of the fuel lines from an injector, cover the filter caps with shipping caps to prevent dirt from entering the injector. Also, protect the fuel lines and fuel connectors from entry of dirt or foreign material.

3. Crank the engine with the starting motor to bring the push rod ends - outer ends - of the injector and valve rocker arms in line horizontally.
4. Remove the two rocker shaft bracket bolts, rocker arm shaft and swing the rocker arm assembly away from the injector and valves. Install rocker arm shaft, rocker arms - bolts (fig. 16) to keep parts from being relocated.
5. Loosen the injector clamp nut and remove the nut, special washer, and clamp.
6. Loosen adjusting screws on injector rack control lever and slide lever away from injector.
7. Free the injector from its seat and lift it from the cylinder head (fig. 16).
8. Cover the injector hole in the cylinder head to keep foreign particles out of the cylinder.
9. Clean the exterior of the injector with fuel oil and dry it with compressed air.

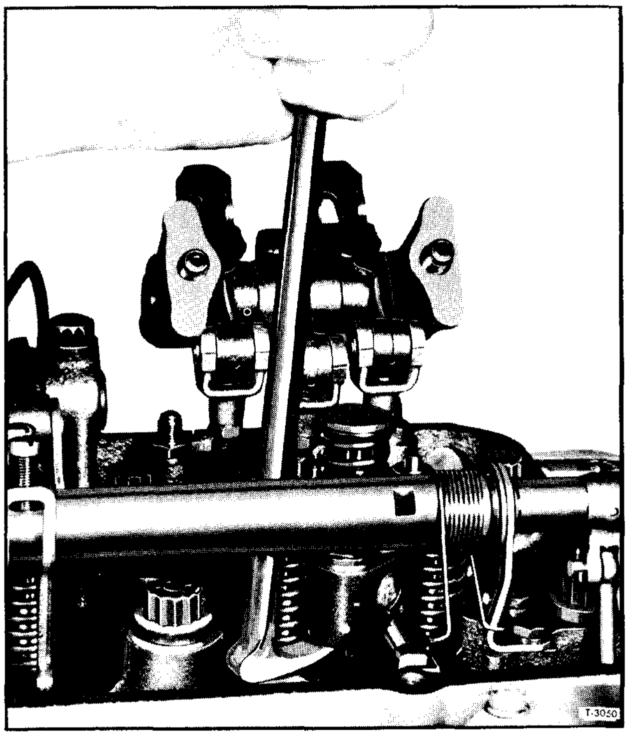


Figure 16—Removing Injector from Cylinder Head

INJECTOR INSTALLATION

NOTE: Refer to "Engine Maintenance and Tune-up" in Section 6C of this manual.

Before installing an injector in an engine, remove the carbon deposits from the beveled seat of the injector tube in the cylinder head. This will assure correct alignment of the injector and prevent any undue stresses from being exerted against the spray tip.

Use injector tube bevel reamer J-5289-9, to clean the carbon from the injector tube. Exercise care to remove ONLY the carbon so that the proper clearance between the injector body and the cylinder head is maintained. Pack the flutes of the reamer with grease to retain the carbon removed from the tube.

Install the injector in the engine as follows:

1. Refer to figure 15 and insert the injector into the injector tube. Be sure the dowel pin in the injector body registers with the dowel pin hole in the head. Next, position the injector rack control lever so the lower end of the lever engages the injector rack.

2. Install the injector clamp, special washer, and nut. Tighten the nut to 20 to 25 foot-pounds torque. Then, check to make sure the clamp does not interfere with the injector follower spring or the exhaust valve springs.

NOTE: Check the injector rack for free movement. Excess torque can cause the injector control rack to stick or bind.

3. Move the rocker arm assembly into position and tighten the rocker arm bracket bolts to 50 to 55 foot-pounds torque on 53 Series and 90 to 100 foot-pounds torque on 71 Series.

IMPORTANT: On four-valve cylinder heads, there is a possibility of damaging the exhaust valves if the exhaust valve bridge is not resting on the ends of the exhaust valves when tightening the rocker shaft bracket bolts. Therefore, note the position of the exhaust valve bridge before, during, and after tightening the rocker shaft bracket bolts.

4. Remove the shipping caps. Then align the fuel lines and connect them to the injector and the fuel connectors. Use socket (J-8932-01) and a torque wrench to tighten the connections to 12 to 15 foot-pounds torque.

CAUTION: DO NOT exceed the specified torque. Excessive tightening will twist or fracture the flared end of the fuel line and result in leaks. Lubricating oil diluted by fuel oil can cause serious damage to the engine bearings.

5. After installing injector(s) in the engine, perform a complete engine tune-up as outlined in Section 6C of this manual. However, if only one injector has been replaced, and the other injectors and governor adjustment has not been disturbed, it will be necessary to adjust the valve clearance and time the injector, also to position the injector rack control lever only on the injector which has been replaced, except the number one cylinder. If the number one injector (which is the injector set to governor) is removed it will be necessary to loosen all injector rack screws and reset the control rack as described in Section 6C of this manual under "Engine Maintenance and Tune-up."

INJECTOR TESTING

If inspection does not reveal any external damage, then a series of tests should be made to determine the condition of the injector to avoid unnecessary overhauling.

An injector that passes all of the tests outlined following may be considered to be satisfactory for service, other than the visual check of the plunger. However, an injector that fails to pass one or more of the tests is unsatisfactory and the faults should be corrected.

Injector Control Rack and Plunger Movement Test

Check to see if the plunger works freely in its bushing and whether the control rack moves back and forth freely.

Place the injector in the injector tester (J-9787)

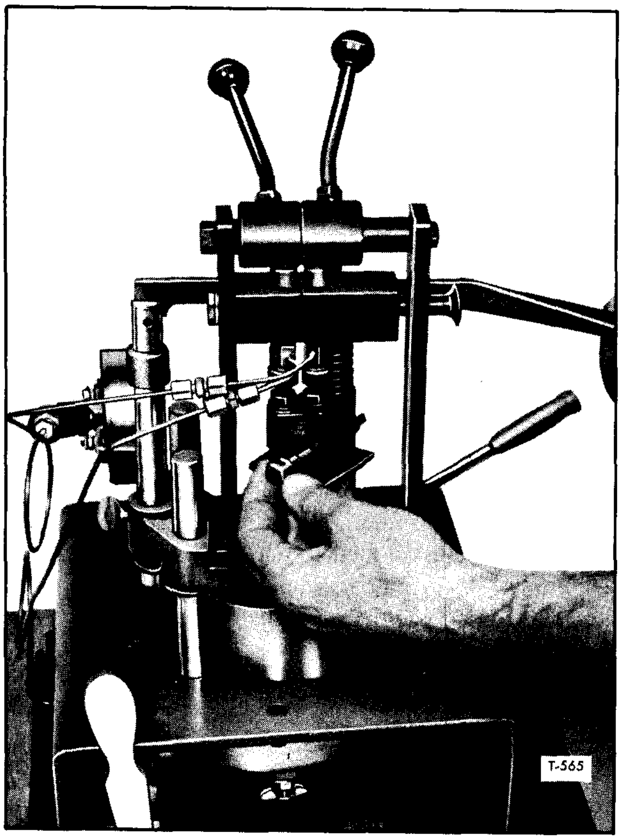


Figure 17—Checking Freeness of Rack and Plunger

(fig. 17), with the dowel in the underside of the injector located in the proper slot or hole in the adapter plate (J-8538-10). Position the injector support and the handle support to the proper height.

Close clamp with inlet tube on injector. Operate pump handle until all air is purged from the test fixture and injector. Then close the outlet clamp.

CAUTION: When testing an injector just removed from an engine, the flow of fuel through the injector on the tester should be the same as in the engine. Connections on the test head of the tester may be changed to obtain the correct direction of flow (fig. 17).

Place the handle on top of the injector follower then close the inlet and outlet clamps to hold the injector in the tester. With the injector control rack held in the NO FUEL position, push the handle down and depress the follower to the bottom of its stroke. Then, very slowly release the pressure on the handle while moving the control rack back and forth, as shown in figure 18, until the follower reaches the top of its travel. If the rack does not move

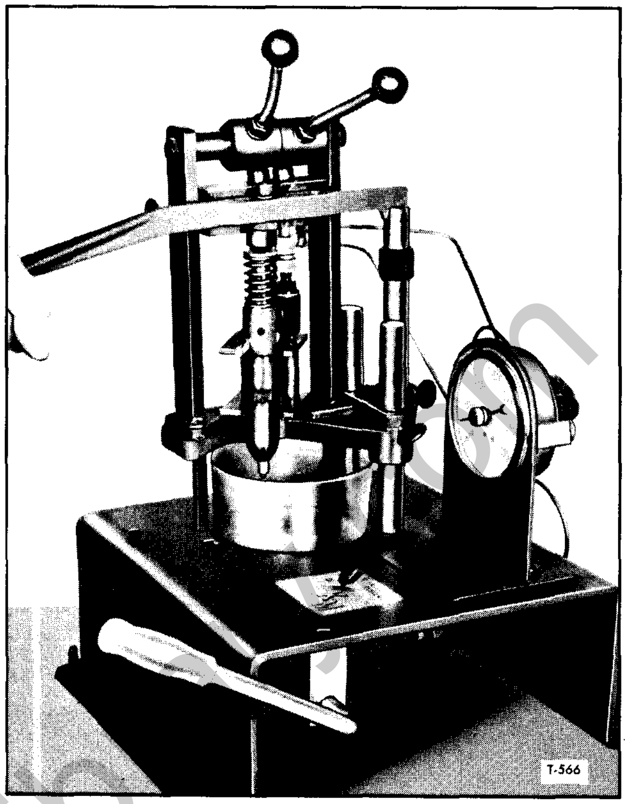


Figure 18—Spray Pattern Test

freely, it indicates that the internal parts of the injector are damaged or dirty.

High Pressure Leak Test

With the injector still mounted in the injector tester, thoroughly dry the injector with compressed air. Then, pump up the tester and maintain a pressure of 1600 to 2000 psi. Inspect for leaks at the injector filter cap gaskets, body plugs, injector nut seal ring, injector rack hole and spray tip orifices. If any of these conditions exist refer to "Trouble-shooting Chart" in appropriate Overhaul Manual.

NOTE: It is normal for some fuel leakage at rack hole due to high pressure fuel being applied to a normally low pressure area in the injector assembly.

IMPORTANT: DO NOT permit the pressure in the injector tester to equal or exceed the capacity to the pressure gauge. Relieve the pressure slowly to avoid damage to the pressure gauge.

Injector Pressure Holding Test

Operate the pump handle to bring the pressure up to approximately 450 psi.

Close the fuel shut-off valve and note the pressure drop. The time for a pressure drop from 450 psi to 250 psi should not be less than 40 seconds.

If the injector pressure drops from 450 psi to 250 psi in less than 40 seconds, the injector should be checked as follows:

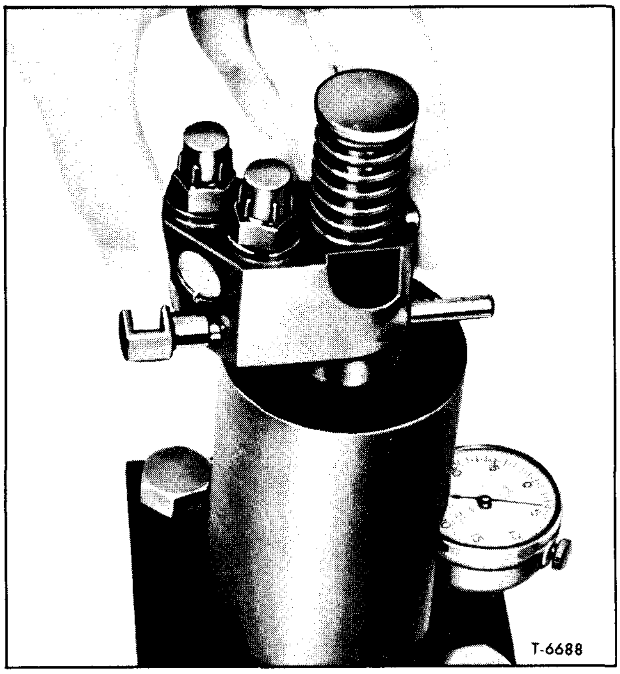


Figure 19—Checking Injector Spray Tip Concentricity

1. Thoroughly dry the injector with compressed air.
2. Open the tester fuel valve and operate the pump handle to maintain the testing pressure.
3. Check for a leak at the injector rack opening. A leak indicates a poor bushing-to-body fit.
4. A leak around the spray tip or seal ring usually is caused by a loose injector nut, a damaged seal ring, or a brinelled surface on the injector nut or spray tip.
5. A leak at the filter cap indicates a loose filter cap or a damaged filter cap gasket.
6. A "dribble" at the spray tip orifices indicates a leaking valve assembly due to a damaged surface or dirt.

Spray Pattern Test

After completing pressure holding test, place the injector rack in the FULL FUEL position.

Operate the injector several times in succession while operating the tester handle at approximately 40 strokes per minute as shown in figure 18. Observe the spray pattern to see that all spray orifices are open and injecting evenly. The beginning and ending of injection should be sharp and the fuel injected should be finely atomized.

CAUTION: To prevent damage to the pressure gauge, do not exceed 250 psi during this test.

If all the spray tip orifices are not open and injecting evenly clean the orifices in the spray tip during injector overhaul. Refer to "Troubleshooting Chart" in appropriate Overhaul Manual.

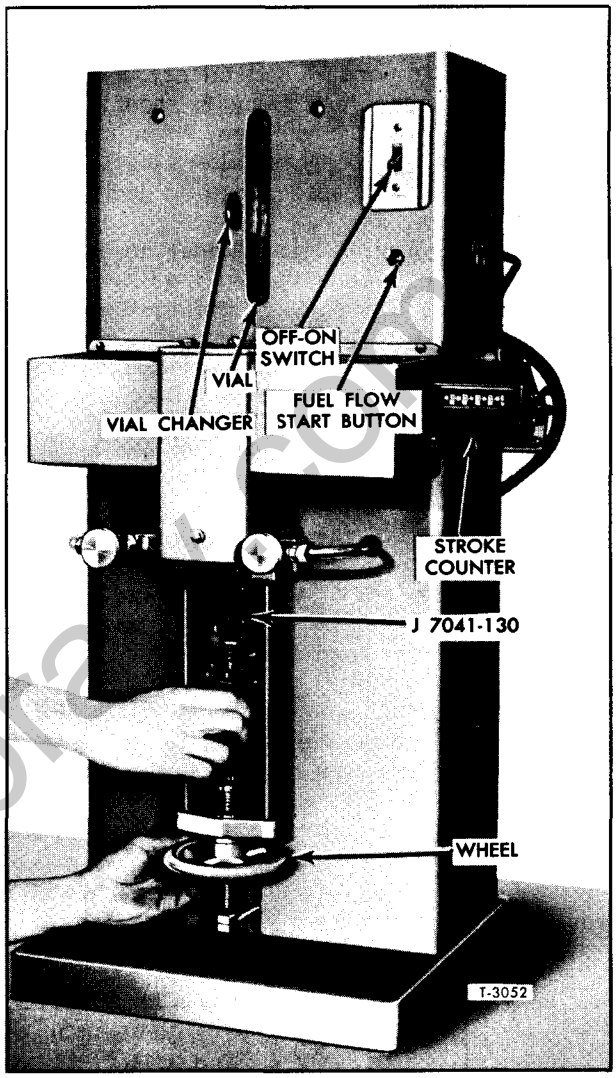


Figure 20—Placing Injector in Comparator

Spray Tip Concentricity Test

The spray tip and the injector nut MUST be concentric within 0.008" to ensure correct alignment of the spray tip in the injector tube. Check the concentricity in the following manner:

1. Place the injector in the concentricity gauge (J-5119) as shown in figure 19.
2. Adjust the dial indicator to "O." Rotate the injector 360 degrees and note the total run-out.
3. If the total run-out exceeds 0.008", remove the injector from the gauge. Loosen the injector nut, re-center the spray tip, tighten the nut to 75 to 85 foot-pounds torque and recheck concentricity.

If, after several attempts, the spray tip cannot be positioned satisfactorily, check the assembly of the entire injector.

Fuel Output Test

When injectors are removed from an engine for output testing and, if satisfactory, reinstalled without disassembly, extreme care should be taken to avoid reversing the fuel flow. When the flow is reversed, dirt trapped by the filters located in the injectors is back-flushed into the injector components.

The fuel manifolds in cylinder heads direct the fuel into the injector through the filter cap located above the fuel rack. To avoid reversing the fuel flow when checking fuel output on the comparator use the appropriate adapter. Do not cross the lines when using adapter (J-7041-130).

Operate the injector in the comparator (J-7041) to check the fuel output as follows:

1. Place the injector in the comparator, as shown in figure 20. Then, turn the wheel to clamp the injector and adapter in position.

NOTE: Make sure the counter on the comparator is pre-set to 1,000 strokes. If for any reason, this setting has been altered, reset the counter to 1,000 strokes by pulling the selector wheel to be changed to the right and rotating it to its proper position; then, release the wheel.

2. Pull the injector rack out to the NO FUEL position.

3. Start the comparator by turning on the switch shown in figure 20.

4. After the comparator has started, push the injector rack into the FULL FUEL position and allow the injector to operate for approximately 30 seconds to purge the air that may be in the system.

5. After 30 seconds press fuel flow start button. This will start the flow of fuel into the vial. The comparator will automatically stop the flow of fuel at a pre-determined number of strokes.

6. After the fuel stops flowing into the vial, pull the rack out to the NO FUEL position.

7. Turn the comparator off and reset counter.

8. Observe the reading on the vial. Refer to "Fuel Output Chart" following:

FUEL OUTPUT CHART

Injector	Fuel Output Min.	Fuel Output Max.
N45	11	17
N55	24	30
N60	30	36
N65 (Brown)	32	38
N65 (White)	38	44

9. The comparator may be used to check and select a set of injectors which will inject the same amount of fuel in each cylinder at a given throttle setting, thus resulting in a smooth running engine.

10. An injector which passes all of the above tests may be put back into service. However, an injector which fails to pass one or more of the tests must be disassembled and rebuilt.

GOVERNOR

NOTE: FOR GOVERNOR ADJUSTMENTS ON ENGINE REFER TO SECTION 6C UNDER "ENGINE TUNE-UP."

Engines requiring a minimum and maximum speed control, together with manually controlled intermediate speeds, are equipped with a limiting speed mechanical governor.

The limiting speed mechanical governors perform the following functions:

1. Controls the engine idle speed.
2. Limits the maximum operating speed of the engine.
3. Gives the operator complete control through out the intermediate range.

The governor assembly number, type, and idle speed range are stamped on the name plate attached to the governor housing. Governor springs and upper levers for 6V-53 engines is illustrated in figure 21, also 6-71 is shown in figure 23, while 8V-71 is shown in figure 22.

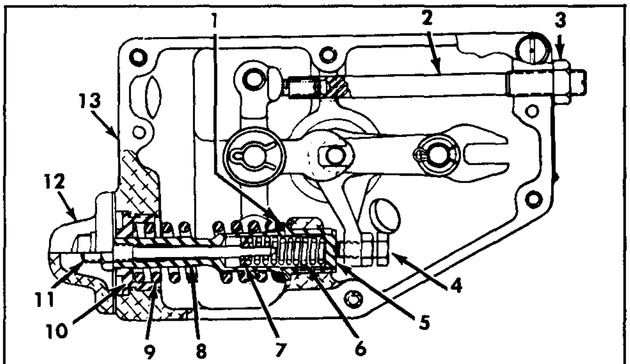
The governor is mounted between in such a manner that one end of the governor weight shaft is splined to a drive plate attached to the driven blower timing gear to provide a means of driving the governor. The other end of the shaft is supported by a bearing in blower drive support.

A cover and lever assembly, control housing, spring housing, and governor weight and shaft assembly are the basic parts of the governor.

OPERATION

The governor holds the injector racks in the FULL FUEL position for starting when the speed control lever is in the idle position. Immediately after starting, the governor moves the injector racks to the position required for idling.

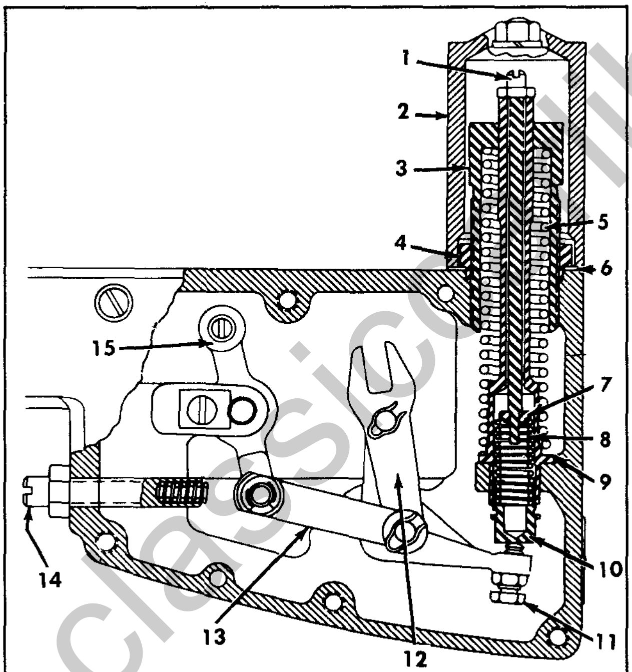
The centrifugal force of the revolving governor low and high speed weights is converted into linear motion which is transmitted through the riser and operating shaft to the operating shaft lever. One end of this lever operates against the



1 High Speed Adjustment Shims
2 Buffer Screw
3 Lock Nut
4 Gap Adjustment Screw
5 Spring Cap
6 Low Speed Spring
7 Spring Seat
8 High Speed Spring Plunger
9 High Speed Spring
10 High Speed Spring Retainer
11 Idle Speed Adjustment Screw
12 Spring Cover
13 Governor Housing

T-4585

Figure 21—Governor Springs and Levers (6V-53 Engine)



1 Idle Speed Adjustment Screw
2 Spring Housing
3 High Speed Spring Retainer
4 Retainer Lock
5 High Speed Spring
6 Gasket
7 Low Speed Spring Seat
8 Low Speed Spring
9 High Speed Spring Plunger
10 Spring Cap
11 Gap Adjustment Screw
12 Differential Lever
13 Connecting Link
14 Buffer Screw
15 Operating Lever

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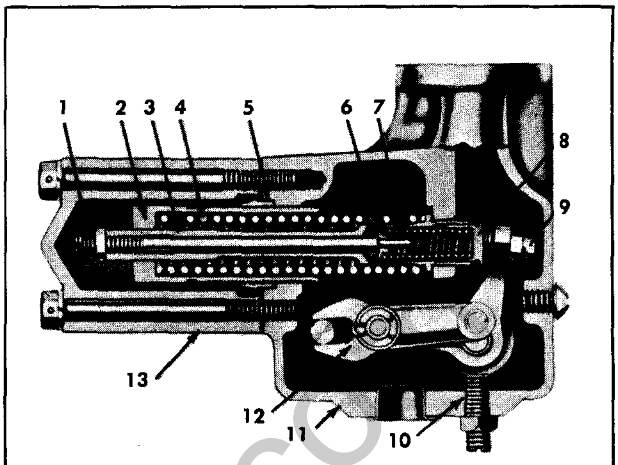
Figure 22—Governor Springs and Levers (8V-71 Engine)



1 Idle Speed Adjustment Screw
2 High Speed Spring Retainer
3 High Speed Spring Plunger
4 High Speed Spring
5 Retainer Lock
6 Low Speed Spring Seat
7 Low Speed Spring
8 Spring Cap
9 Gap Adjustment Screw
10 Buffer Screw
11 Governor Housing
12 Differential Lever
13 Spring Housing

T-4587

Figure 23—Governor Springs and Levers (6-71 In-Line Engine)

high and low speed springs through the spring cap, while the other end provides a moving fulcrum on which the differential lever pivots.

When the centrifugal force of the revolving governor weights equal the force exerted by the high or low speed spring (depending on the speed range), the governor stabilizes the engine speed for a given setting of the governor speed control lever.

In the low speed range, the centrifugal force of the low and high speed weights operate together against the low speed spring. As the engine speed increases, the centrifugal force of the low and high speed weights together compress the low speed spring until the low speed weights are against their stops, thus limiting their travel, at which time the low speed spring is fully compressed and the low speed spring cap is within 0.0015" of the high speed plunger.

Throughout the intermediate speed range the operator has complete control of the engine because the low speed gap is closed and the low speed weights are against their stops, and the high speed weights are not exerting enough force to overcome the high speed spring.

As the speed continues to increase, the centrifugal force of the high speed weights increases until this force can overcome the high speed spring and the governor again takes control of the engine, limiting the maximum engine speed.

Fuel rods are connected between the control link operating lever and each injector control tube lever. A vertical pin in the differential lever engages the slot in the control link lever fork. This arrangement provides a means for the governor to change the fuel settings of the injector rack control levers.

The engine idle speed is determined by the force exerted by the governor low speed spring. When the governor speed control lever is placed in the idle position, the engine will operate at the speed where the force exerted by the governor low speed weights will equal the force exerted by the governor low speed spring.

The engine idle speed is adjusted by changing the force on the low speed spring. This is accomplished by turning the idle speed adjusting screw as outlined in this section.

The engine maximum no-load speed is determined by the force exerted by the high speed spring. When the governor speed control lever is placed in the maximum speed position, the engine will operate at a speed where the force exerted by the governor high speed weights will equal the force exerted by the governor high speed spring.

The maximum no-load is adjusted by increasing or decreasing the tension on the high speed spring. This is done on 6V-53 engines by changing the thickness of the shim pack in the governors shown in figure 21, or by turning high speed spring retainer on Series 71 engines shown in figures 22 and 23. Adjust high speed spring as instructed in Section 6C under "High Speed Spring Adjustment."

LUBRICATION

The governor is lubricated by a spray of pressurized lubricating oil from the blower rear end plate to the blower timing gears which distribute this oil to various parts of the governor. Oil splash from the gear train provides lubrication for the governor weights and shaft. Excess oil overflows into the gear train compartment and returns to the crankcase.

CHECKING GOVERNOR OPERATION

Governor difficulties are usually indicated by speed variations of the engine; however, it does not necessarily mean that all such speed fluctuations are caused by the governor. Therefore, when improper speed variations appear, the unit should be checked as follows:

1. Make sure the speed changes are not the result of excessive load fluctuations.

2. Check engine to be sure that all cylinders are firing properly. If any cylinder is not firing properly, the injector must be removed, tested and if necessary, reconditioned.

3. Check for bind that may exist in the governor operating mechanism or in the linkage between the governor and injector control tube.

4. With the fuel rod connected to the injector control tube lever, the mechanism should be free from bind throughout the entire travel of the injector racks. If friction exists in the mechanism, it may be located and corrected as follows:

a. If an injector rack sticks or moves too hard, it may be due to the injector hold-down clamp being too tight or improperly positioned. To correct this condition, loosen the injector clamp, reposition, and tighten to 20 to 25 foot-pounds torque.

b. A binding injector may result from internal dirt accumulation, defective plunger and bushing, or a bent injector rack. The injector must be removed and tested as outlined previously in this section.

c. An injector rack may bind as the result of an improperly positioned control rack lever. Loosen control rack adjusting screws. If this relieves the bind, relocate the lever on the control tube and position the rack as outlined in this section.

d. The injector control tube may bind in its support brackets, thus preventing free movement of the injector racks to their NO FUEL position due to tension of the return spring.

e. This condition may be corrected by loosening and realigning the control tube supporting brackets. If the control tube support brackets were loosened, realigned and tightened, the injector racks must be repositioned as outlined under "Injector Timing and Governor Adjustments" in Section 6C.

f. A bent control tube return spring may cause friction in the operation of the injector control tube. If a control tube return spring has been bent or otherwise distorted, install a new spring.

g. Check for bind in pin which connects the fuel rod to the injector control tube lever and replace pin if necessary.

h. If, after making the preceding checks, the governor fails to control the engine properly, the governor should be removed and reconditioned.

FUEL SUPPLY PUMP

The fuel pump, illustrated in figures 24 and 25, is the positive displacement gear-type. The pump circulates fuel from the fuel supply tank to the fuel injectors. The pump circulates the excess supply of fuel through the injectors and the unused portion of fuel goes back to the fuel tank by means of a fuel return manifold located in each cylinder head and a fuel return line.

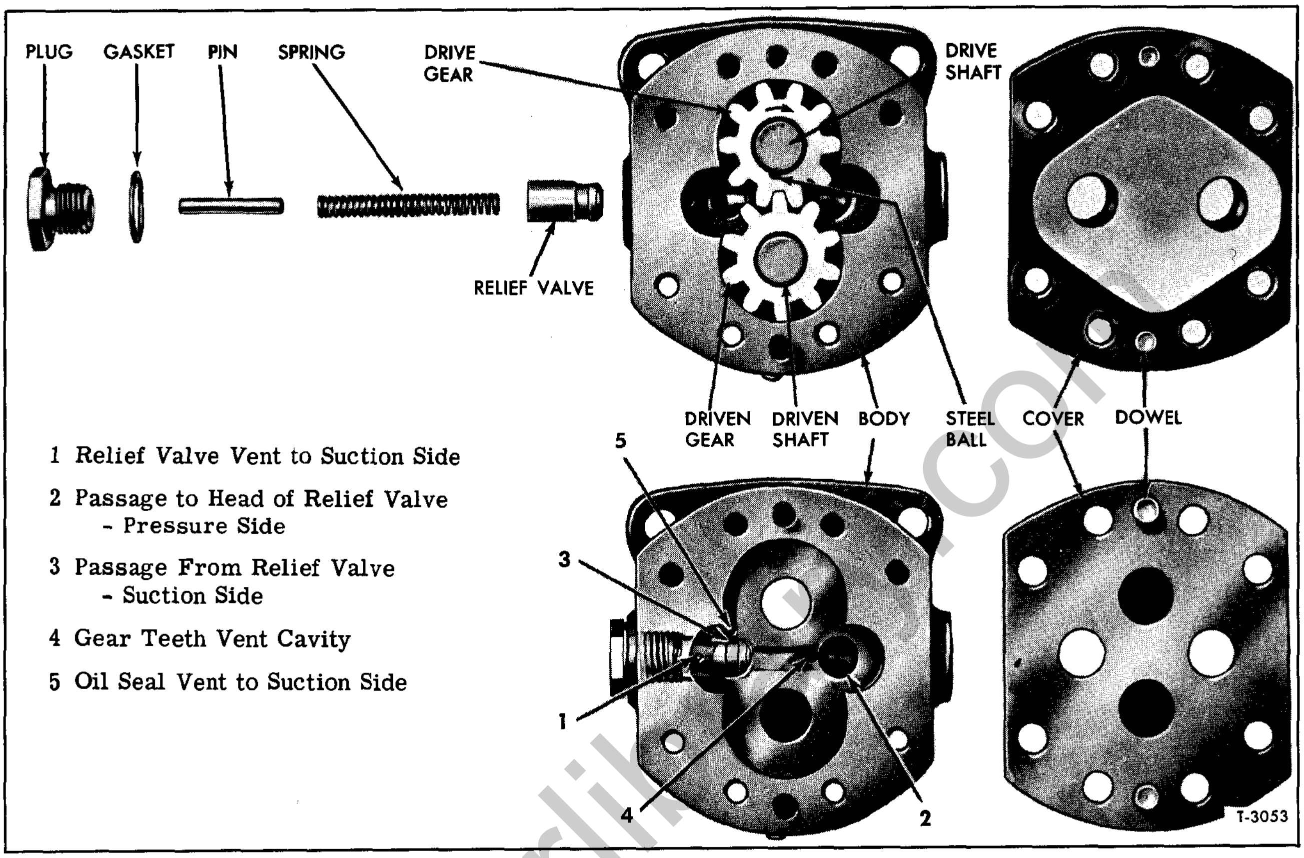


Figure 24—Fuel Pump Valving and Rotation (Right Shown)

A spring loaded relief valve, incorporated in the pump body, normally remains in the closed position, operating only when pressure on the outlet side (to secondary fuel filter) becomes excessive due to a plugged filter or fuel line. The valve will open at a pressure of approximately 65 to 75 pounds per square inch, allowing fuel to return through a passage in the body from the pressure side to suction side of the pump. A small hole in the pump body allows fuel oil back of the relief valve to bleed into the gear compartment. Otherwise, the fuel might become trapped and prevent the valve from opening (refer to fig. 24).

Two oil seals are pressed into the bore in the flanged side of the pump body with the sealing lips of seals facing away from the fuel pump gears, as shown in figure 25. Two tapped holes in the underside of pump body, between the seals, furnish a means of attaching piping for draining off any leakage. If leakage exceeds one drop per minute, the seals must be replaced. The fuel pump should maintain a fuel pressure at the fuel inlet passage of 50 to 70 psi at 1800 rpm engine speed. Lift on the suction side of pump should not exceed 48 inches.

Fuel pumps are furnished in left- or right-hand rotation according to the engine model, and are stamped "L.H. IN" and "R.H. IN." These pumps are not interchangeable, nor can a pump made for one rotation be rebuilt for the other rotation.

NOTE: The fuel pump used on the 6V-53 engine is R.H. rotation and is mounted on the flywheel housing; it is driven by the accessory drive gear. The fuel pump used on the 6-71 engine is right-hand rotation and driven by lower rear blower rotor. The fuel pump used on the 8V-71 engine is a left-hand rotating pump and is driven by the right front blower rotor.

TESTING FUEL PUMP

If engine operation indicates insufficient supply of fuel to the injectors and the fuel level is not low in the supply tank, check the fuel flow between the restricted fitting in the fuel return passage in the cylinder head and the fuel supply tank.

Checking Fuel Flow

1. Disconnect the fuel return line from the fitting at the fuel tank and hold the open end of the line in a convenient receptacle.
2. Start and run the engine at 1200 rpm (no load) and measure the fuel flow return for a period of one minute.

NOTE: Approximately 0.8 gallon of fuel should flow from the fuel return line per minute.

3. Be sure all connections are tight so that no air will be drawn into the fuel system; then immerse the end of the fuel line in the fuel container. Air bubbles rising to the surface of the liquid will indicate a leak on the suction side of the pump.

4. If the fuel flow is insufficient for satisfactory engine performance, then:

a. Renew the element in the primary filter. Start the engine and run it at 1200 rpm (no load) to check the fuel flow. If the fuel flow is still unsatisfactory, perform Step b. following:

b. Renew the element in the secondary filter, If the fuel flow is unsatisfactory do as instructed in Step c. following:

c. Substitute another fuel pump that is known to be in good condition and again check the flow. Follow "Removal" and "Installation" instructions given later in this section.

d. When changing a fuel pump, clean all fuel line fittings with compressed air and be sure all fuel line connections are tight.

Checking Fuel Pump

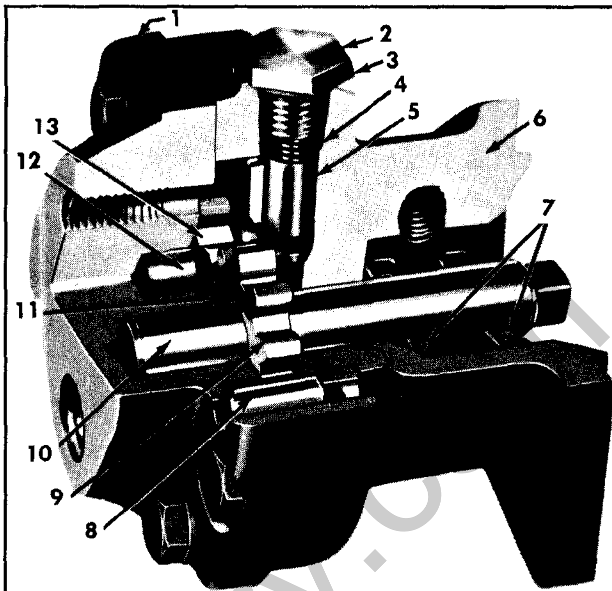
If the fuel pump fails to function satisfactorily, check for broken pump shaft, or dirt in relief valve, before removing the pump from the engine:

1. Insert the end of a wire through one of the pump body drain holes, then crank the engine momentarily and see if wire vibrates. Vibration will be felt if pump shaft rotates.

2. Without removing the pump from the engine, unscrew valve screw (fig. 24), then remove spring, pin, and valve. Wash parts and blow out valve cavity with compressed air. Check parts for scoring or damage. Install valve parts, if satisfactory.

FUEL PUMP REMOVAL

1. Disconnect fuel tubes from inlet and outlet openings of the fuel pump.



1	Pump Cover	8	Dowel Pin
2	Valve Plug	9	Drive Gear
3	Gasket	10	Drive Shaft
4	Valve Spring	11	Retaining Ball
5	Relief Valve	12	Driven Shaft
6	Pump Body	13	Driven Gear
7	Oil Seals		

TPM-7334-1

Figure 25—Sectional View of Typical Fuel Pump Assembly

2. Unscrew three pump attaching bolts and washers and withdraw pump and gasket. Clean gasket surface.

3. Check drive coupling and if broken, replace.

FUEL PUMP INSTALLATION

1. Affix a new gasket to pump body and locate pump drive coupling over square end of fuel pump drive shaft.

2. Install fuel pump on engine and secure with three bolt and washer assemblies.

3. Connect inlet and outlet fuel lines to the fuel pump.

The satisfactory performance of a Diesel engine depends on sufficiently high compression pressure and the injection of the proper amount of fuel at the right time.

It is important that extreme care be exercised in the handling and storage of diesel fuel oil, as absolute cleanliness is essential to satisfactory engine operation.

CUMMINS DIESEL ENGINE

Contents of this section are listed in Index below:

NOTE

For servicing of fuel injection and governor system on Cummins Diesel Engine refer to "Cummins Operation and Maintenance Manual."

FUEL FILTERS

For servicing of fuel filters on cummins engine refer to appropriate Operation and Maintence Manual."

ACCELERATOR AND THROTTLE LINKAGE ADJUSTMENT

NOTE: Hand throttle must be in "OFF" position and all linkage components installed.

CONVENTIONAL CAB MODELS

(Refer to Figure 1)

1. Make sure that throttle cable "A" clears governor lever "B" by 1/8" in idle position. If necessary loosen trunnion (fig. 3).
2. Adjust pedal stop "C" to one inch dimension (fig. 1) from floor mat "G."
3. Adjust turn-buckle "D" to obtain three-inch dimension between accelerator pedal "E" (at idle position) and floor mat "G" (fig. 1). Tighten jam nuts.
4. Check to make sure governor lever "B" overrides full throttle position at governor before accelrator pedal "E" hits stop "C." Adjust if necessary.
5. If trunnion was loosened or does not have 1/8" clearance as in Step 1 previously, adjust as described under "Hand Throttle Adjustment."

TILT CAB MODELS

(Refer to Figure 2)

NOTE: Cab must be in normal drive position.

1. Make sure that throttle cable stop trunnion clears governor lever by 1/8" (fig. 3) in idle position. If necessary, loosen trunnion at governor lever.
2. Slide bracket "A" (loosen attaching bolts) until 1/8" clearance exists between lever "B" and roller "C" (fig. 2). Torque the attaching bolts to 6 to 8 foot-pounds.
3. Rotate lever assembly "B" to full throttle and adjust stop bolt "D" to contact accelerator pedal (fig. 2). Tighten jam nut "E" securely.
4. If trunnion was loosened or does not have 1/8" clearance as in Step 1 above (fig. 3), adjust as described following under "Hand Throttle Adjustment."

HAND THROTTLE ADJUSTMENT

The hand throttle is operated by a flexible wire cable. Engine speed is increased as the knob

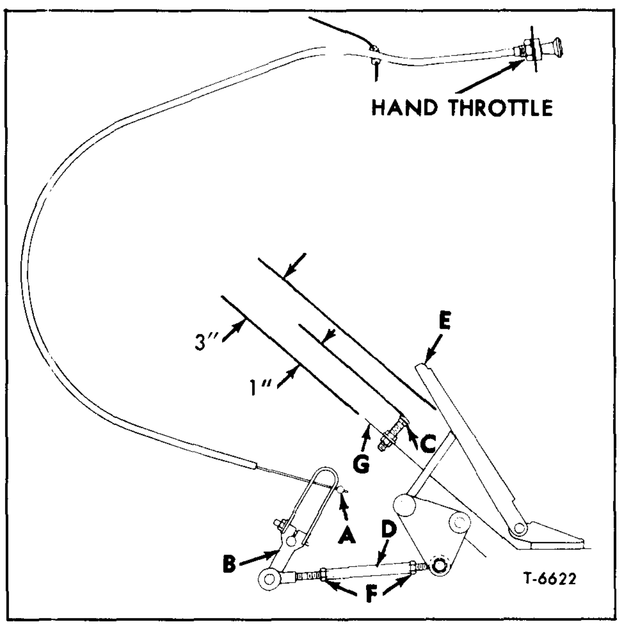


Figure 1—Conventional Cab Accelerator and Throttle Linkage

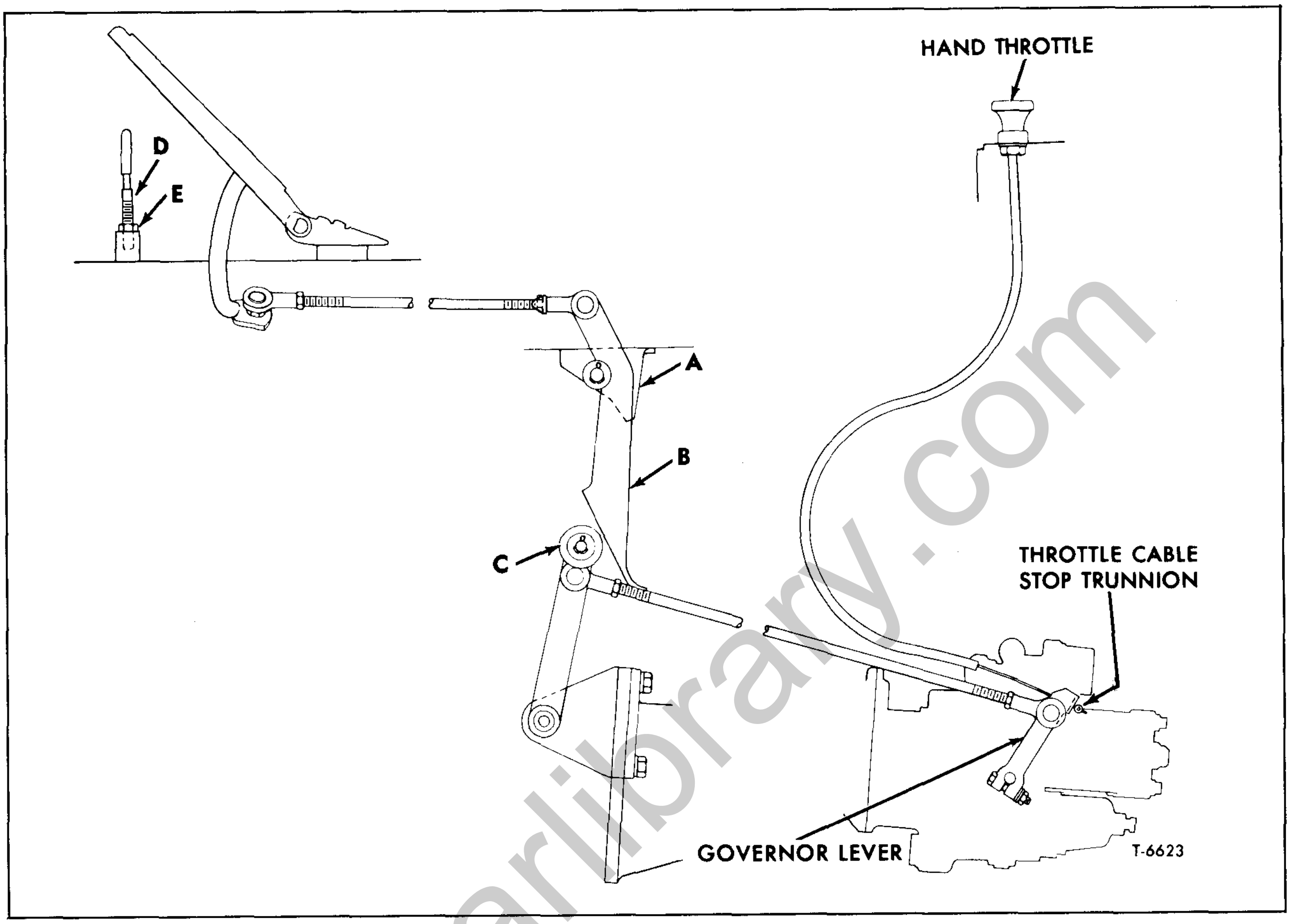


Figure 2—Tilt Cab Accelerator and Throttle Linkage

is pulled and may be locked in place at any desired speed by turning knob until locking device is engaged. To release the throttle from the locked position, turn the knob one-quarter turn in either direction and push the knob all the way in to return the engine speed to a normal idle.

1. Check the accelerator linkage for free movement and be sure that the return spring moves the linkage to idle position.
2. Inspect the cable housing for kinks or damaged areas. If badly kinked or damaged, replace the cable.
3. Check to see that the cable housing is clamped securely at the support bracket.
4. Push the knob all the way in and loosen the screw attaching the trunnion to the wire.

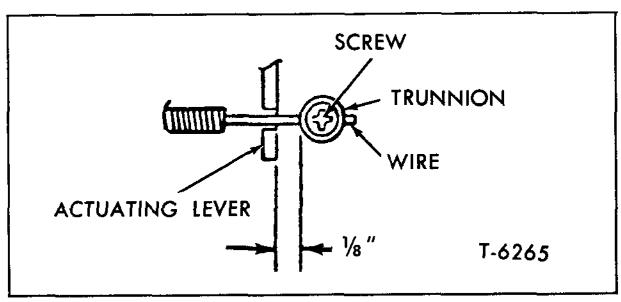


Figure 3—Control Cable Trunnion Installation (Typical)

5. Position the trunnion on the wire with 1/8-inch clearance between the trunnion and actuating lever (see fig. 3). Tighten the trunnion screw.

SECTION 6T

AIR COMPRESSORS AND GOVERNORS

GENERAL INFORMATION

Midland-Ross and Bendix Westinghouse air compressors are interchangeable as complete assemblies on many models covered by this manual (see "Air Compressor Model Application Chart"). On such models, the mechanic must determine which of the two makes is used on a specific vehicle before proceeding with adjustment or repair of any compressor. All other models come equipped with either a Bendix-Westinghouse compressor or a Midland-Ross compressor as specified in the "Air Compressor Model Application Chart" at end of this section.

Offered as optional equipment on 70 and 90 series vehicles are compressors of greater capacity than those used as standard in regular production. All procedures in this section apply to optional as well as the standard equipment compressors.

Refer to the "Air Compressor Model Application Chart" to determine which compressor is used on any specific truck.

NOTE: Information relative to air compressors used on all models equipped with Cummins engine covered by this manual is contained in Cummins Operation and Maintenance Manual. Service procedures for air compressor governors on Cummins equipped vehicles is the same as covered later in this section.

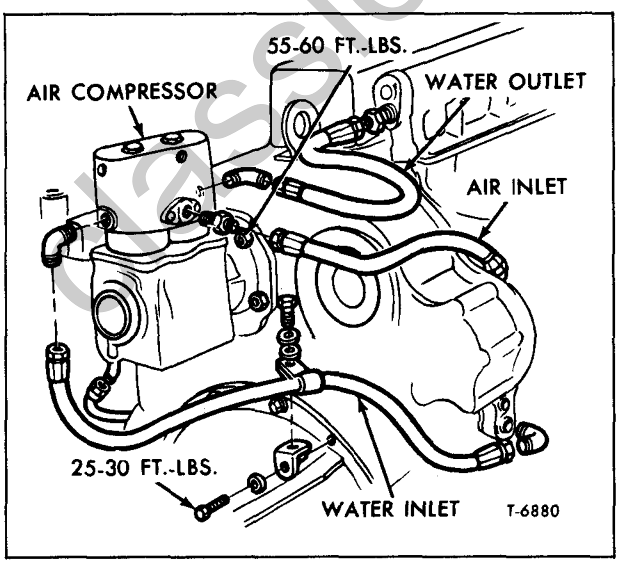


Figure 1—Air Compressor Installation (Gear Driven) (Typical)

DESCRIPTION

The air compressors covered in this manual are two-cylinder, piston-type compressors. The rated capacity of an air compressor is its piston displacement in cubic feet-per-minute when operating at 1250 rpm. Standard air compressors are rated at 7¼ or 12 cubic-feet-per-minute and optional compressors are rated at 12 or 14½ cubic-feet-per-minute. The Model Number is shown on a plate which is attached to the cylinder block.

The Bendix-Westinghouse compressor used on some models is flange-mounted at rear of engine and gear driven (see fig. 1). All other compressors covered here are driven by a belt from the crankshaft pulley (see fig. 2).

The gear driven compressors are water-cooled from the engine cooling system. The belt driven compressors are either water-cooled or cooled by air from the fan assembly.

All compressors are lubricated by oil from the engine lubrication system.

Each compressor is equipped with a governor assembly, which is attached to the cylinder head or cylinder block by a bracket. This governor, in conjunction with the air compressor unloading mechanism, controls the compression of air.

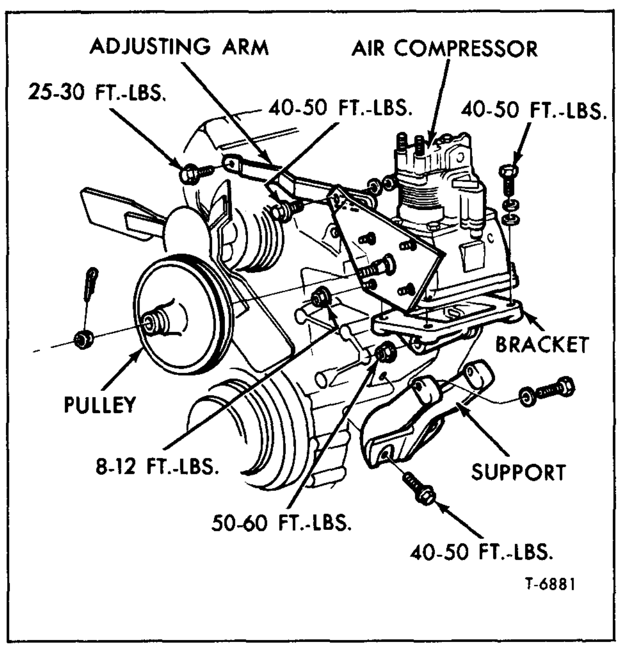


Figure 2—Air Compressor Installation (Belt Driven) (Typical)

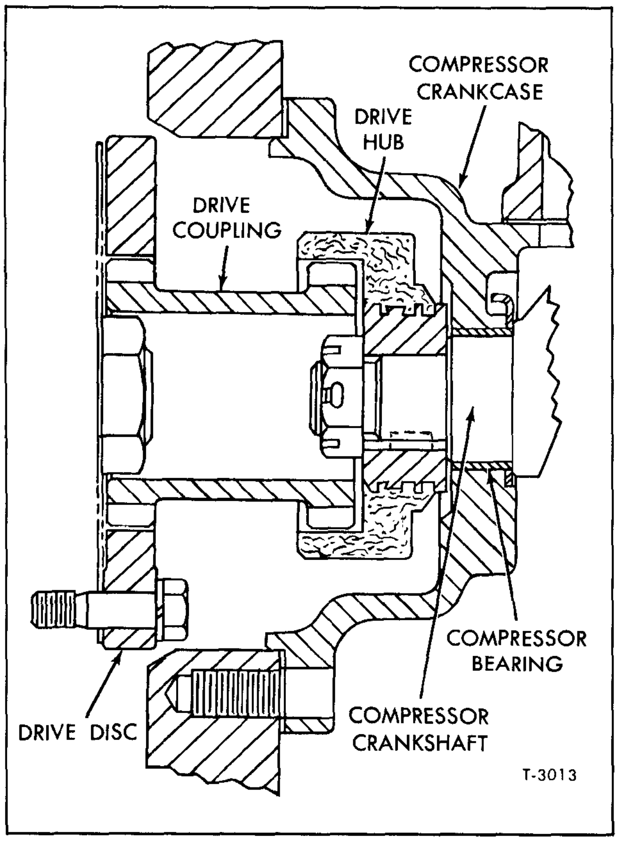


Figure 3—Air Compressor Gear Drive (6V-53 Diesel Engine)

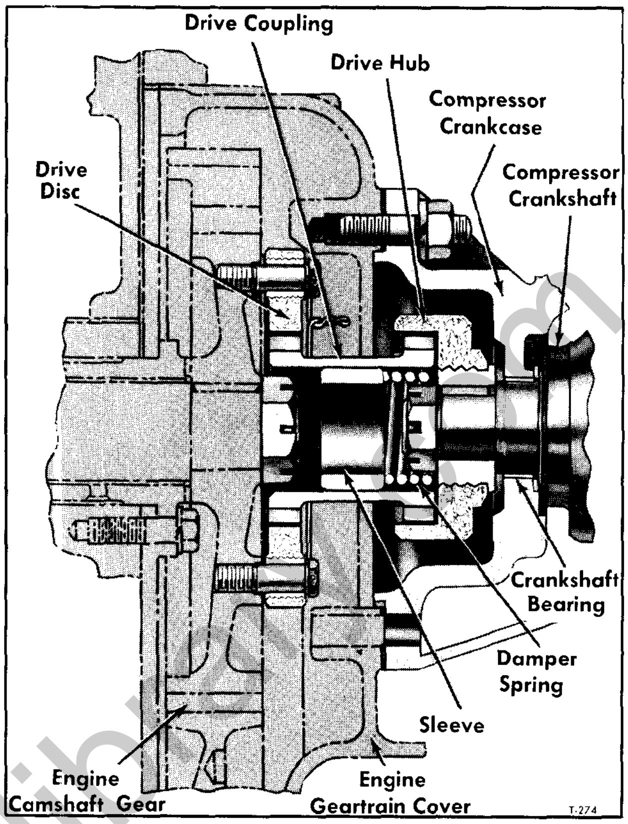


Figure 4—Air Compressor Gear Drive (71 Series Diesel Engine)

COMPRESSOR MOUNTING AND DRIVE

(Refer to Figure 2)

On belt driven air compressors the mounting and drive installations vary from one model to another but all have the same basic principle of attachment and adjustment. An adjusting arm with a slot at one end) connects the air compressor to the vehicle engine (generally at the engine front cover). This arm is attached solidly to the engine with a bolt or a bolt and nut. The slotted end of arm is attached with a nut and bolt to an adjusting arm bracket fastened to compressor.

The air compressor is mounted on a base with four bolts. This base incorporates a lubricating oil return drain hole and a boss which permits the use of two smaller pivot bolts as a method of fastening the bottom of the air compressor. This base also provides a pivot point for drive belt tension adjustment. The pivot bolt and nut secure the air compressor assembly to a support bracket which is attached to the vehicle engine at the cylinder block or lower front engine cover (dependent on vehicle model).

The size, shape, and relative arrangement of the adjusting arm, the adjusting arm bracket, the base and the support bracket are determined by the requirements for each individual model.

All belt driven compressors are equipped with a proper size pulley to produce the rpm recommended by the manufacturer. It is of the utmost importance that the correct one be used.

Some pulleys have a puller groove in the hub. Use this groove when removing pulley to prevent damage. Use extra care in removing a pulley without the groove.

For belt tension adjustment, refer to procedure under "Drive Belt Maintenance and Adjustment."

Gear driven compressor models are flange-mounted to an adapter assembly on rear of gear train cover, and are driven directly from engine camshaft. A hub with internal fiber teeth is keyed to compressor crankshaft and secured by a nut and cotter pin (figs. 3 or 4). An internal-toothed fiber drive disc is bolted to the engine camshaft gear. A drive coupling assembly is splined to fiber hub at one end and camshaft drive disc at the other end.

COMPRESSOR LUBRICATION

Lubricating oil, under pressure from the engine lubricating system, enters drilled crankshaft through the crankshaft bearing cap and lubricates the connecting rod bearings. Some of the oil that flows between sides of connecting rod bearings and cheeks on crankshaft is sprayed upward. This oil lubricates the piston pin bushings and the cylinder walls. The oil drains from compressor into the mounting bracket and returns directly to the engine crankcase. Oil lines should be kept open freely for proper compressor lubrication.

COMPRESSOR AIR INTAKE

There are three different air strainers (filters) used on these compressors. There are two used on Midland-Ross air compressors made of paper fibers or paper. There are two used on Bendix-Westinghouse air compressors, made of paper or polyurethane foam. The purpose of each is to filter incoming air and to remove impurities, moisture, dirt, etc., from incoming air before it is compressed into air brake system.

The compressor runs continuously while the engine is running but the actual compression of air is controlled by the governor and the unloading mechanism. During the downstroke of the piston (inlet valve open) a slight vacuum is created, drawing atmospheric air through the filter into the cylinder chamber. This air is compressed by the upward piston stroke (inlet valve closed) and is forced out through the discharge valve into the truck air brake system (reservoir).

Of the three different filter elements used, one can be cleaned and reinstalled in the compressor as the paper fiber or the paper type CANNOT be cleaned and reused.

AIR COMPRESSOR AIR STRAINER (Fig. 5)

The air compressor air strainer should be inspected and replaced or cleaned at regular intervals.

Paper or paper fiber element-type air compressor cleaner is used on some models and should be replaced when element shows visible evidence of damage or a dirt clogged condition or is oil saturated.

Foam-type element is cleanable in cleaning solution by immersing and squeezing until clean. Apply oil sparingly.

AIR COMPRESSOR AND GOVERNOR MAINTENANCE

Service compressor air strainer at regular

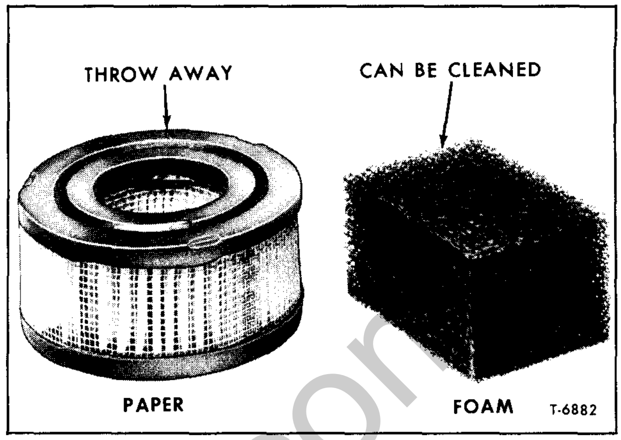


Figure 5—Air Compressor Air Intake Filters

intervals. Perform the following inspection and maintenance operations at intervals determined by truck operating conditions.

1. Remove cylinder head and clean carbon from inlet and discharge valves. If valves are damaged in any way, replace with new parts.
2. Make sure compressor discharge line is not choked with carbon.
3. Check governor cut-in and cut-out pressures and adjust, if necessary. Refer to "Governor Adjustment" in this section.
4. Check compressor and bracket mounting bolts for looseness, and tighten if necessary.
5. Make sure all oil, water, and air line connections are tight and not leaking.
6. Check compressor drive belt tension and adjust if necessary.
7. When draining engine cooling system to prevent freezing, be sure to remove drain plug from compressor cylinder block on water-cooled models.
8. Check compressor mounting bolts, as a loose mounting will result in severe damage to drive coupling components.

DRIVE BELT MAINTENANCE AND ADJUSTMENT

Drive belts used on models covered by this manual are made of dacron or rayon. These drive belts must be kept at proper tension. A loose belt will lower the output of the compressor, while a tight belt will eventually cause bearing failure. A regular, periodic inspection is recommended to check condition and tension of drive belt. Replace belt if frayed or badly worn.

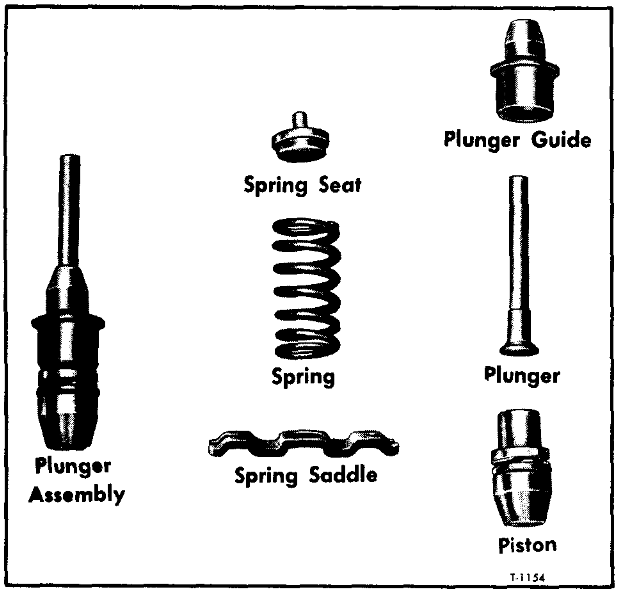


Figure 6—Unloader Assembly Components (B-W)

ADJUSTMENT

1. Loosen bolt at adjusting arm. Loosen pivot bolt at compressor mounting bracket.
2. Position compressor so that a reading of 120-130 lbs. (new belt) or 80 - 90 lbs. (used belt) is obtained on Belt Tension Gauge (J-23573).
3. Tighten adjusting arm bolt and/or nut securely. Tighten pivot bolt nut.

NOTE: On a new vehicle, or after a new belt is installed, check belt tension twice in first 200 miles of operation.

COMPRESSOR REPLACEMENT

REMOVAL (BELT DRIVEN)

1. Exhaust compressed air from air system.
2. Disconnect air, water, and oil lines from compressor.
3. Loosen pivot bolt at compressor base, then loosen compressor adjusting arm bolt. Tilt compressor and remove drive belt from compressor pulley.
4. Disconnect adjusting arm from compressor by removing adjusting arm bolt.
5. Remove bolts attaching compressor crankcase to mounting bracket. Lift air compressor assembly off mounting bracket.

REMOVAL (GEAR DRIVEN)

1. Drain engine cooling system.
2. Disconnect water, air, and oil lines from compressor.
3. Remove bolts attaching air compressor to flywheel housing assembly. Pull compressor straight back and remove from vehicle.

INSPECTION (ALL MODELS)

1. Clean oil supply line to compressor and if possible, run engine a few seconds to be sure oil supply to compressor is flowing freely.
2. Clean oil return line or passage through compressor mounting bracket to be sure oil from compressor crankcase can return to engine crankcase. NOTE: On flange mounted compressor, oil passage is an integral part of compressor crankcase.
3. Lubricate compressor cylinder walls and bearings with lubricating oil before placing compressor in position.
4. Clean or replace any damaged or dirty air lines or water lines which may be corroded before connecting them to the compressor.

INSTALLATION (BELT DRIVEN)

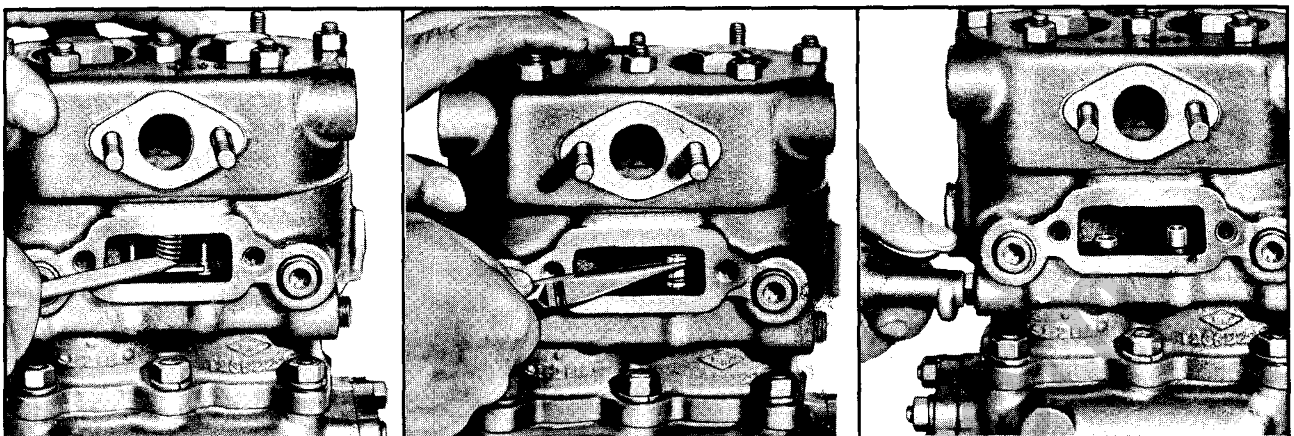
1. Use new gasket and make sure mating surfaces of compressor crankcase and mounting bracket are clean. Position compressor on mounting bracket and attach with bolts. Connect compressor adjusting arm to bracket on side of compressor cylinder head or block. Do not tighten.
2. Connect air, water, and oil lines to compressor. Check all connections for tightness.
3. Place drive belt in compressor pulley and adjust belt tension as previously directed.
4. On water cooled models, make sure drain plug is installed in compressor cylinder block, then fill cooling system.
5. Adjust governor as directed later.

INSTALLATION (GEAR DRIVEN)

1. Before installing compressor, examine hub on compressor crankshaft and drive disc on camshaft gear for worn or broken teeth.
2. Make sure mating surfaces of air compressor or flange and flywheel housing assembly are clean. Place new compressor to adapter gasket on studs.
3. Insert drive coupling into hub on crankshaft. Place compressor in position on flywheel housing assembly, guiding teeth on coupling into mesh with teeth in drive disc. Install nuts and washers. Tighten nuts to 55-65 foot-pounds torque.
4. Connect all water, air, and oil lines, making sure connections are tight.
5. Make sure drain plug is installed in compressor cylinder block, then fill cooling system.
6. Adjust air compressor governor as directed later.

UNLOADER ASSEMBLY REPLACEMENT

Unloader assemblies on both Bendix-Westing-



REMOVING OR REPLACING UNLOADER SPRING | REMOVING UNLOADER PISTON | REMOVING UNLOADER PISTONS USING AIR PRESSURE TPM-4363

Figure 7—Removing Unloader Components (B-W)

house and Midland-Ross compressors can be replaced without removing compressor from vehicle. Since the unloader assemblies differ by manufacturer, a separate procedure is given for each.

BENDIX-WESTINGHOUSE

Parts are available in a kit for replacing unloader assembly. Unloader parts (fig. 6) may be changed without removing cylinder head as follows:

Removal (Fig. 7)

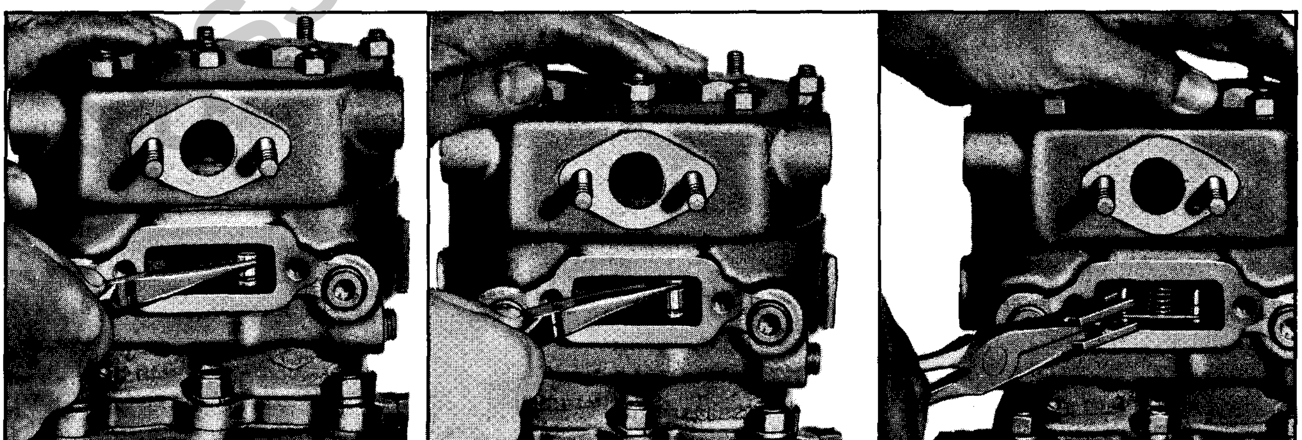
1. Remove air inlet elbow and discard gasket.
2. Insert screwdriver blade under unloader spring and raise spring off unloader spring saddle. Remove spring and spring saddle.
3. Lift each plunger guide and remove guide and plunger. Lift pistons out of bores. If piston is not easily removed, build up air pressure in system until governor cuts out, raising piston. If compressor has been removed from vehicle, use air pressure as shown in figure 7.

Installation (Fig. 8)

1. Carefully insert each piston, complete with O-ring and back-up ring, in bore.
2. Slide plunger guide down over unloader plunger. Place each guide and plunger in position above unloader piston, then push guide down over top of piston.
3. Install unloader spring and spring saddle. Make sure saddle rests squarely on top of plunger guides, and make sure top of spring engages spring seat in cylinder block.
4. Install new gasket at air inlet and connect air inlet elbow.

MIDLAND-ROSS

The following procedure includes disassembly



INSTALLING UNLOADER PISTON | INSTALLING GUIDE AND PLUNGER ON UNLOADER PISTON | INSTALLING UNLOADER SPRING AND SADDLE TPM-4034

Figure 8—Installing Unloader Components (B-W)

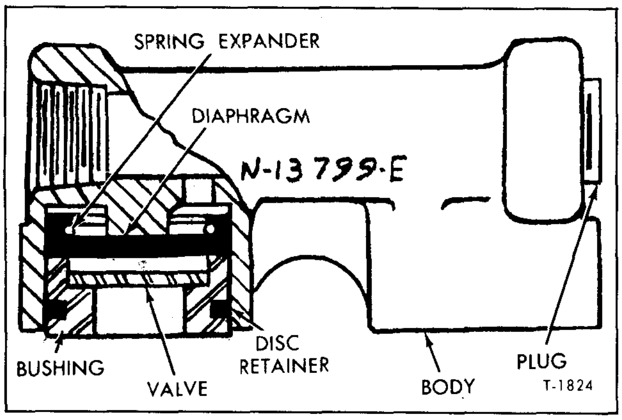


Figure 9—Unloader Assembly (M-R)

and assembly instructions as well as removal and installation. If a new unloader is being installed omit the unnecessary steps.

Removal and Disassembly (Fig. 9)

1. Disconnect both ends of tube between governor and unloader. Remove tube assembly.
2. Remove two bolts attaching unloader assembly to cylinder head.
3. Remove unloader assembly. Remove inlet valve plunger and plunger spring.
4. Remove bushing, valve, diaphragm, and expander spring from body. Should difficulty be encountered in removing these parts, apply air pressure to body to force out these parts.
5. Remove the rubber retainer from the bushing.

Assembly and Installation (Fig. 9)

1. Apply thin film of light engine oil to bushing, diaphragm, and body before assembly.
2. Install expander spring around inside of diaphragm, then install these two parts in body.
3. Install rubber retainer on bushing.
4. Place valve in recess of bushing, then install in body.
5. Install plunger spring and inlet valve plunger.
6. Set unloader assembly in place on cylinder head and fasten with two bolts.
7. Connect tube assembly from unloader to governor.
8. Test assembly with air pressure. Unloader should withstand a pressure of 100 psi without leaking.

AIR COMPRESSOR GOVERNOR

DESCRIPTION

The governor, operating in conjunction with air compressor unloading mechanism, automatically controls air pressure in the air brake or air supply system between the desired, predetermined maximum and mimimum pressures. The air compressor runs continually while the engine runs, but actual compression of air is controlled by the governor which stops or starts compression when the maximum or minimum pressures are reached.

MAINTENANCE

Every 500 operating hours or after every 15,000 miles, clean or replace governor filters.

Every 3,000 operating hours or after every 100,000 miles, disassemble the governor and clean and inspect all parts. Repair governor if necessary.

GOVERNOR TESTS

Operating Test

Start the engine and build up air pressure in system. Observe reading on air pressure gauge in gauge panel when governor cuts-out, stopping compression of air by the compressor. Reading on gauge when governor cuts-out should be within range shown on "Governor Adjustment Chart."

With the engine still running, slowly reduce air pressure in the system by applying and releasing brakes. Observe pressure registered by gauge when governor cuts-in and compression is resumed. Gauge reading should be within range shown on "Governor Adjustment Chart."

Before condemning or adjusting the governor, be sure the dash air gauge is registering accurately. Use an accurate test gauge to check pressure registered by the dash gauge. If the pressure settings of the governor are inaccurate or it is necessary that they be changed, adjust governor as described below under "Governor Adjustment Chart."

Leakage Test

Leakage checks on the governor are made at its exhaust port in both cut-in and cut-out positions. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston grommet (B-W only). In the cut-out position check the exhaust port to determine if leakage is present at the exhaust valve seat or stem grommet. In this position leakage could also be past the upper grommet (B-W only).

If there is excessive leakage, overhaul governor.

GOVERNOR ADJUSTMENT

The following procedure covers adjustment with compressor installed on vehicle. Governor is mounted on a bracket which is attached to compressor cylinder head or block, dependent upon model.

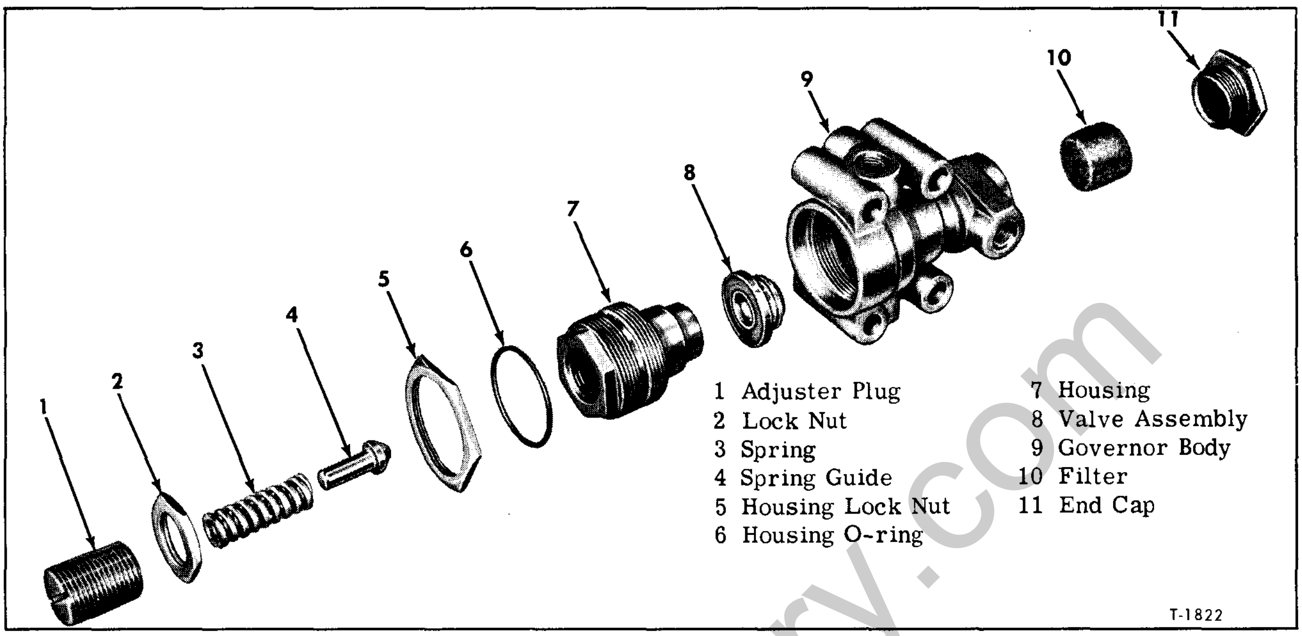


Figure 10—Compressor Governor (M-R)

GOVERNOR ADJUSTMENT CHART		
GOVERNOR	CUT-IN	CUT-OUT
All Midland-Ross	85 psi	100-107 psi
All Bendix-Westinghouse except below	102-108 psi	123-131 psi

NOTE: It is most important that air compressor governor cut-in and cut-out pressures be within the ranges shown in the above chart. Adjustment procedures are as follows:

Midland-Ross (Fig. 10)

1. Loosen lock nut. Use screwdriver at adjuster plug.
2. Turn adjuster plug in (clockwise) to increase cut-out setting, or out (counterclockwise) to decrease setting. One complete turn of adapter plug will change cut-out pressure 20 psi.
3. When cut-out pressure setting of 100-107 psi is attained, lock adjuster plug with lock nut.

Bendix-Westinghouse (Fig. 11)

1. Unscrew rubber cover and remove it from the governor.
2. Loosen adjusting screw lock nut.

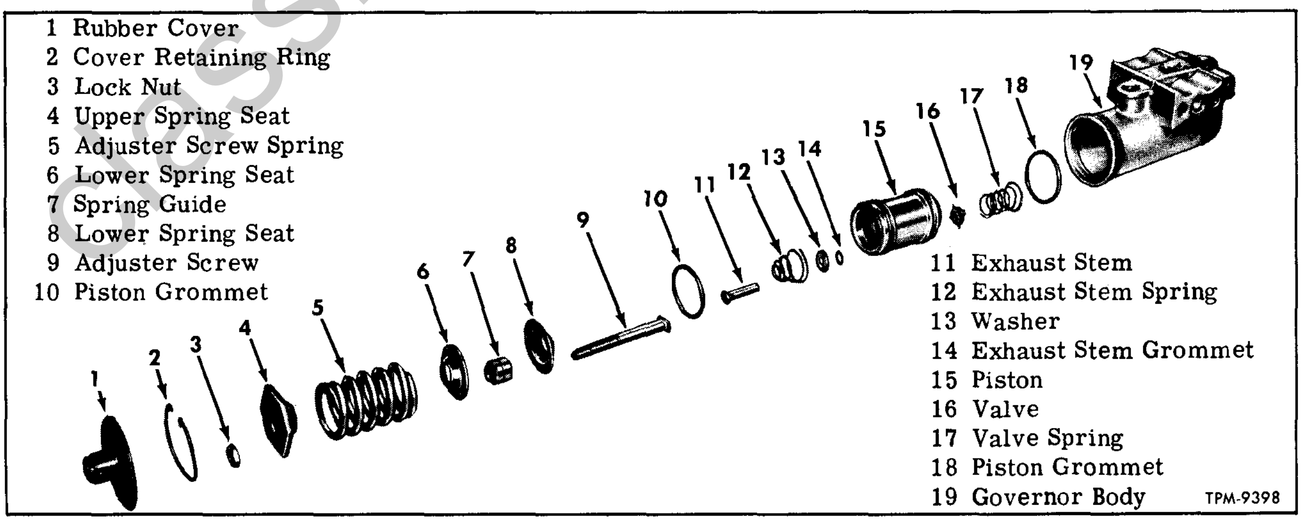


Figure 11—Compressor Governor (B-W)

3. Using a screwdriver, turn adjusting screw counterclockwise to raise pressure settings. Turn adjusting screw clockwise to lower the pressure settings.

4. When adjustment is completed, tighten adjusting screw lock nut.

5. Install cover on the governor.

GOVERNOR REPLACEMENT

The following procedures apply to all governors on both Midland-Ross and Bendix-Westinghouse air compressors:

Removal

1. Exhaust air from system.
2. Disconnect both ends of tube from governor to unloader.
3. Remove nuts and/or bolts which fasten governor to compressor or bracket.
4. Remove governor.

Installation

1. Place governor in position on compressor or bracket.
2. Install nuts and/or bolts which fasten the governor.
3. Connect both ends of tube to governor and unloader.
4. Build up pressure in system and check for operation and leaks.

TROUBLESHOOTING

COMPRESSOR FAILS TO MAINTAIN SUFFICIENT PRESSURE

Dirty intake strainer.
Restriction in compressor cylinder head intake or discharge cavities or in discharge line.
Leaking or broken discharge valves.
Excessive wear.
Drive belt slipping.
Inlet valves stuck open.
Worn inlet valves.
Excessive system leakage or usage.

NOISY OPERATION

Loose drive pulley.
Restrictions in cylinder head or discharge line.
Worn or burned out bearings.
Worn drive coupling.
Compressor not getting proper lubrication.
Excessive wear.

COMPRESSOR PASSES EXCESSIVE OIL

Excessive wear.
Dirty air strainer. (Improper air strainer maintenance.)
High inlet vacuum.
Small oil return line.
Excessive oil pressure.
Oil supply or return lines to compressor flooded.
Defective or worn oil seal rings in end cover.
Piston rings not properly installed.
Back pressure from engine crankcase.

COMPRESSOR NOT UNLOADING

Defective unloader pistons or bores.
Intake cavity restrictions.
Defective governor.
Unloader line or cavity to governor restricted.
Unloader mechanism binding or stuck.

AIR COMPRESSOR MODEL APPLICATION CHART

TRUCK MODELS	COMPRESSOR MODEL	MANU-FACTURER	CU. FT. CAPACITY	TYPE COOLING	TYPE DRIVE	TYPE FILTER
			STANDARD			
HM, JM,	N-6400-N	M-R	7¼	Air	Belt	Paper Fibers
TM 80	or 281977	B-W	7¼	Air	Belt	Paper
HV, JV 70	280094	B-W	7¼	Water	Gear	Foam
TV 70	280367	B-W	7¼	Water	Gear	Paper
HI, JI	282626	B-W	12	Water	Gear	None
MH	282745	B-W	12	Water	Gear	None
MI	283031	B-W	12	Water	Belt	Paper
90 Series						
DI, FI	282010	B-W	12	Water	Gear	None
DH, FH	282012	B-W	12	Water	Gear	None
			OPTIONAL			
HM, JM,	N-6000-H	M-R	12	Air	Belt	Paper
TM 80	or 282623	B-W	12	Air	Belt	Paper
HV, JV 70	280095	B-W	12	Water	Gear	Foam
TV 70	280368	B-W	12	Water	Gear	Paper
90 Series						
DI, FI	282011	B-W	14½	Water	Gear	None
DH, FH	282013	B-W	14½	Water	Gear	None

NOTE

The air compressor is the only source of air for vehicles with air brakes. It is most important, air intake filters and drive belts (when used) be serviced at regular intervals.

SECTION 6Y

ENGINE ELECTRICAL

This section, covering "ON-VEHICLE MAINTENANCE AND REPLACEMENT" of charging system components, is divided into sections shown in Index following:

NOTE: Refer to applicable wiring diagrams in "Wiring Diagrams" at the end of Section 12 for electrical circuits and connections for standard and optional equipment on vehicles covered by this manual.

BATTERY

The standard and optional type batteries used on vehicles covered by this manual are shown in the "Model Application Chart" following:

BATTERY MODEL APPLICATION CHART

TRUCK SERIES	PART NO.	MODEL
STANDARD		
HM/JM/TM-80	1980038	E-3000; Y-71
HV/JV/TV-70	1980760	8DR-205
HI/JI/MI-90; DI/FI-90	1980760	8DR-205
MH-90 (Two Batteries in Parallel)	1980760	8DR-205
HN/JN-90; DN/FN-90 (Four Batteries)	1980716	4HR-160
DC/DH/FC/FH-90 (Four Batteries)	1980718	7DR-200

BATTERY MODEL APPLICATION CHART (CONT.)

TRUCK SERIES	PART NO.	MODEL
OPTIONAL		
HM/JM-80	1980974	9H9-974
HI/JI/MI/HN/JN-90 (Two Batteries Connected in Parallel)	1980760	8DR-205
HM/TM-80 (Two Batteries in Series)	1980926	3H-926
DI/FI-90 (Four Batteries)	1980716	4HR-160
DI/FI-90 (Two or Four Batteries)	1980718	7DR-200

GENERAL

On some vehicles, hard rubber cell covers are fitted over terminal posts of the elements. Cell connectors are welded between intermediate terminal posts of adjoining cells to establish a series circuit.

The battery shown in figure 1 features a one-piece cover of hard rubber construction which reduces the tendency for corrosion to form on top of the battery. The cover is bonded to the case with sealing compound that forms an air seal between the cover and case. The cell connectors pass through sealed holes in cell partitions to connect elements together in the shortest practical distance (fig. 2). With the length of the electrical circuit inside the battery reduced, the internal voltage drop is decreased.

The cells are properly filled when the electrolyte level reaches the bottom of the "split vent" at the bottom of the vent well. The split vent is a visual level fill feature in the cell cover. The electrolyte surface will appear distorted when it contacts the split vent.

Figure 1—Typical Battery with One Piece Cover

The battery has three major functions to perform on the vehicle:

1. It provides a source of current for starting the engine.
2. It acts as a stabilizer to the voltage in the electrical system.
3. It can, for a limited time, furnish current when electrical demands of the system exceed output of the generator.

BATTERY PRECAUTIONS

1. The electrical circuit is NEGATIVE GROUND. Installing battery with positive terminal grounded will result in serious damage to the generator, battery, and battery cables.
2. When using a booster battery or charger, connect negative battery or charger terminals together and positive battery or charger terminals together.
3. DO NOT smoke near a battery which is being charged.

COMMON CAUSES OF BATTERY FAILURE

When a battery fails, the cause of failure may lie outside the battery itself. For this reason, when a battery failure is encountered, do not be satisfied to merely recharge or replace it. Find the cause of the failure and prevent recurrence of the trouble. Listed below are some of the common causes of battery failure:

1. Defect in generating system such as high resistance, slipping generator drive belt, faulty generator or regulator.
2. Overloads caused by defective starter or excessive use of accessories.
3. Battery abuse, including failure to keep battery top clean, cable clamps clean and tight, and improper addition of water to the cells.
4. Hardened battery plates, commonly called "sulfation," due to battery being in a low state of charge over a long period of time.

5. Physical defects such as shorted cells, loss of active material from plates, etc.

6. Driving conditions or requirements under which the vehicle is used only for short drives.

BATTERY MAINTENANCE

FILLING BATTERY

Batteries are equipped with "Visual Level" cell covers to facilitate checking electrolyte level and lessen the possibility of overfilling the battery. The cell covers are molded with a long, circular, tapered vent well with two small vertical slots diametrically opposite. Viewed from above with the vent plugs removed, the lower end of the vent well appears as a ring with small portions of the circumference missing. As water is added to the cell, the surface of the rising liquid contacts the slotted lower end of the vent well, causing a distortion of the reflecting surface of the liquid which is very noticeable. Thus, the lower end of the vent well serves as a reference point in determining proper electrolyte level. The cell is properly filled when the surface of the electrolyte touches the bottom of the vent well. If some overfilling occurs, the amount can be estimated readily by the height of liquid in the vent well. It should be kept in mind that the "visual level" vent wells cannot prevent overfilling, but are rather an aid to proper servicing. Overfilling should be avoided at all times, since it contributes to premature battery failure by causing loss of electrolyte. Loss of electrolyte results in poor performance of the battery and causes excessive corrosion of cables, connections, and battery hanger.

All batteries having a one-piece cover are equipped with an electrolyte level indicator, installed in the second cell cap from the positive battery post. The level indicator is a specially designed vent plug having a transparent rod extending through the center. When electrolyte is at proper level, the lower tip of the rod is immersed, and the top of the rod will appear as a dark (black) spot in the center of the vent cap. When the electrolyte level drops below normal the spot will change from black to an off-white color. When the indicator shows water is needed, all cells must be checked and adjusted to their correct level using colorless, odorless, drinking water.

ELECTROLYTE LEVEL

The electrolyte level in the battery should be checked regularly. In hot weather, particularly during prolonged driving, checking should be more frequent because of more rapid loss of water. If the electrolyte level is found to be low, then colorless, odorless, drinking water should be added to each cell until the liquid level rises to the split vent located in the bottom of the vent well. DO NOT OVERFILL because this will cause loss of electrolyte resulting in poor performance, short life, and excessive corrosion.

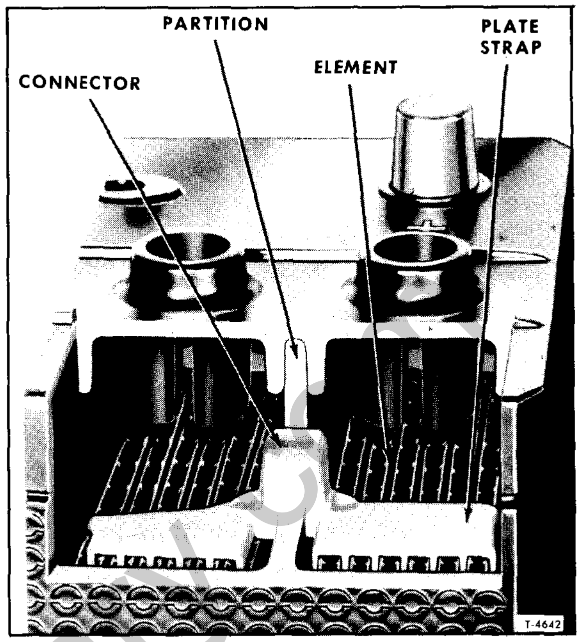


Figure 2—Internal View of Cells

> **CAUTION: During service, only water should be added to the battery, not electrolyte.**

The liquid level in the cells should never be allowed to drop below the top of the plates, as the portion of the plates exposed to air may be permanently damaged with a resultant loss of performance.

CLEANING AND INSPECTION

The external condition of the battery should be checked periodically for damage or presence of dirt and corrosion. The battery top should be kept clean to prevent the accumulation of acid film and dirt which may permit current to flow between the terminals resulting in a slow discharge of the battery. For best results when cleaning the battery top, wash first with a diluted ammonia or soda solution to neutralize any acid present, then flush with clean water. Care must be taken to keep vent plugs tight, so that the neutralizing solution does not enter the cells.

Cables

To insure a good electrical contact, cables should be clean and tight on battery posts. If battery posts or cable terminals are corroded, the cables should be disconnected and the terminals and clamps cleaned separately with a soda solution and a wire brush. After cleaning and installing clamps, apply a thin coating of multi-purpose grease on the cable clamps to retard corrosion.

Carrier and Hold-Down

The battery carrier and hold-down should be clean and free from corrosion before installing the battery. The carrier should be in a sound mechanical condition so that it will support the battery securely and keep it level.

To prevent the battery from shaking in its carrier, the hold-down bolts should be tight (60-80 in.-lbs.). However, the bolts should not be tightened to the point where the battery case or cover will be placed under a severe strain.

CHARGING GUIDE FOR BATTERIES

Below is a suggested list of battery charging rates. Refer to applicable chart.

CHART 1: For dry charged batteries being activated with electrolyte at a temperature under 60°F., or with batteries which are expected to go into immediate operation in below freezing weather.

Amp-Hour Capacity	Dry Battery Warm-up Charge
100 or Less	10 Min.
	15 Amps
Over 100	10 Min.
	30 Amps

CHART 2: For batteries which require a boost charge for the "Light Load Test" procedures.

Amp-Hour Capacity	Light Load Test Boost Charge
100 or Less	20 Min.
	50 Amps
Over 100	30 Min.
	60 Amps

CHART 3: For batteries which have become discharged and require charging. It should be recognized that slow charging is the best and only method of completely recharging batteries. However, since time is often of importance, two other methods are offered for partial battery re-charges listed in this chart.

Amp-Hour Capacity	Slow Charging	Fast Charging	Emergency Boost Charging
100 or Less	24 Hours	1-1/2 Hrs.	30 Minutes
	4 Amps	40 to 50 Amps	40 to 50 Amps
Over 100	24 Hours	3 Hours	1-1/2 Hours
	9 Amps	40 to 50 Amps	40 to 50 Amps

BATTERY CHARGING

There are three methods of recharging batteries which differ basically in the length of time the battery is charged and the rate at which charging current is supplied. One is the Slow Charge method, the second is the Fast Charge method, and the third is the Emergency Boost Charge method. Before recharging the battery by any method, check the electrolyte level and adjust.

NOTE: Refer to "Charging Guide For Batteries" previously for a suggested list of battery charging rates.

When a battery is being charged, an explosive gas mixture forms in each cell. Part of this gas escapes through holes in the vent plugs and may form an explosive atmosphere around the battery if ventilation is poor. This gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas causing an internal explosion which may shatter the battery; therefore, do not smoke near a battery which is being charged or which has been recently charged and exercise care when connecting or disconnecting booster leads or cable clamps on a charger. Poor connections are a common cause of electrical arcs which cause explosions.

SLOW CHARGING

The Slow Charge method supplies the battery with a relatively low current flow for a relatively long period of time. This is the only method that will bring the battery to a full state of charge.

The Slow Charge method consists of charging at approximately a 4 ampere rate for 24 hours or more, if necessary, to bring the battery to full charge. A fully charged condition is reached when the cells are gassing freely and three corrected specific gravity readings taken at hourly intervals show no increase.

FAST CHARGING

The Fast Charge method supplies current to the battery at a 40 to 50 ampere rate for a 1½-hour period of time. If the electrolyte temperature reaches 125°F., before the 1½-hour period is completed, the battery must be taken off charge temporarily, or the charging rate reduced to avoid damage to the battery.

Although a battery cannot be brought to a fully charged condition during Fast Charge, it can be substantially recharged or "boosted." In order to bring the battery to a fully charged condition, the charging cycle must be finished by the Slow Charge method.

EMERGENCY BOOST CHARGING

In cases where the battery is not sufficiently charged to crank the engine, an emergency boost charge may be applied as a temporary expedient in order to crank the engine. The Emergency Boost Charge method consists of charging at a 40 to 50 ampere rate for a period of one-half hour.

It should be particularly noted that the Emergency Boost Charge will not necessarily restore the battery to a useful state of charge for continued service. After an Emergency Boost Charge, failure to charge the battery further, either by a long uninterrupted driving period or by the Fast Charge or Slow Charge method, may result in failure to crank the engine the next time cranking is attempted. A battery should never be condemned on the basis of failure to crank the engine after an emergency boost charge. Although an emergency boost charge may put enough energy into the battery to crank the engine once, further charging usually is necessary in order to create a sufficient reserve to crank a second and third time.

BATTERY TESTS

Testing procedures are used to determine whether the battery is (1) good and usable, (2) requires recharging or (3) should be replaced. Analysis of battery conditions can be accomplished by performing a Visual Inspection, Instrument Test, Full Charge Hydrometer Test, and the Light Load Test.

IMPORTANT: Do not attempt to perform the Light Load Test on vehicles equipped with batteries having a one-piece cover (fig. 1).

VISUAL INSPECTION

The first step in testing the battery should be a visual inspection, which very often will save time and expense in determining battery condition.

1. Check the outside of the battery for a broken or cracked case or a broken or cracked cover. If any damage is evident, the battery should be replaced.
2. Note the electrolyte level. Levels that are too low or too high may cause poor performance.
3. Check for loose terminal posts, cable connections, and for evidence of corrosion. Correct as required before proceeding with tests.

INSTRUMENT TEST

NOTE: A number of suppliers have approved testing equipment available, such as the tester (J-22552).

These testers have a programmed test procedure consisting of a series of timed discharge and charge cycles, requiring approximately 2 to 3 minutes, that will determine the condition of the battery with a high degree of accuracy. When using these testers, follow procedures recommended by the tester manufacturer. The battery should not be charged prior to testing as doing so may alter the test results.

If a tester is not available, the "Specific Gravity Cell Comparison Test" may be used as an alternate method, but with a sacrifice in testing accuracy.

1. Measure specific gravity of each cell, regardless of state of charge.
2. If specific gravity readings show a difference between the highest and lowest cell of .050 (50 points) or more, the battery is defective and should be replaced.

NOTE: New batteries which have become completely discharged over a relatively long period of time, such as during vehicle storage, should be tested by the hydrometer method. Batteries discharged to this degree cannot be accurately tested using equipment requiring load capability comparison tests.

FULL CHARGE HYDROMETER TEST

The specific gravity of the electrolyte varies not only with the percentage of acid in the liquid, but also with temperature. As temperature increases, the electrolyte expands so that the specific gravity is reduced. As temperature drops, the electrolyte contracts and specific gravity increases Unless these variations are noted, the specific gravity obtained by the hydrometer may not give a true indication of the concentration of acid in the electrolyte.

Corrections can be made for temperature by adding .004 (4 points of gravity) to the hydrometer reading for every 10°F., that the electrolyte is above 80°F., or by subtracting .004 for every 10°F., that electrolyte is below 80°F.

1. Remove battery from the vehicle and adjust electrolyte level in each cell by adding colorless, odorless, drinking water.
2. Fully charge the battery at the slow charging rate as covered under "Battery Charging" earlier in this section.
3. Using a hydrometer, measure specific gravity of electrolyte in each cell. If any cell reads less than 1.230 (corrected to 80°F.) the battery should be replaced.

CAUTION: DO NOT take hydrometer readings immediately after water has been added. Water must be thoroughly mixed with electrolyte by charging for at least 15 minutes at a rate high enough to cause vigorous gassing.

4. If any cell reads above 1.310, the battery may be returned to service. However, specific gravities above 1.310 will result in poor service and short battery life.

BATTERY LIGHT LOAD TEST

IMPORTANT: DO NOT attempt to perform this test on vehicles equipped with batteries having a one-piece cover (fig. 1).

Check electrical condition of each cell as follows (refer to fig. 3):

1. If electrolyte level in each cell is low, adjust to proper level by adding colorless, odorless, drinking water.

2. Place load on battery by cranking engine. If engine starts, turn off ignition immediately. If engine does not start, hold starter switch "ON" for 3 seconds, then release.

3. Turn on headlights (low beam). After one minute, with lights still "ON" read voltage of each battery cell with voltmeter, compare readings with the following:

Good Battery (Fig. 3, View A)

If all cells read 1.95 volts or more and the difference between the highest and lowest cell is less than .05 volt, battery is good.

Good Battery (Fig. 3, View B)

If cells read both above and below 1.95 volts and the difference between the highest and lowest cell is less than .05 volt, battery is good but requires charging. See "Charging After The Light Load Test" later in this section.

Replace Battery (Fig. 3, View C)

If any cell reads 1.95 volts or more and there is a difference of .05 volts or more between the highest and lowest cell, replace the battery.

Discharged Battery (Fig. 3, View D)

If all cells read less than 1.95 volts, battery is too low to test properly. FAILURE OF THE METER TO REGISTER ON ALL CELLS DOES NOT INDICATE A DEFECTIVE BATTERY. Boost charge battery and repeat "Light Load Test." (See

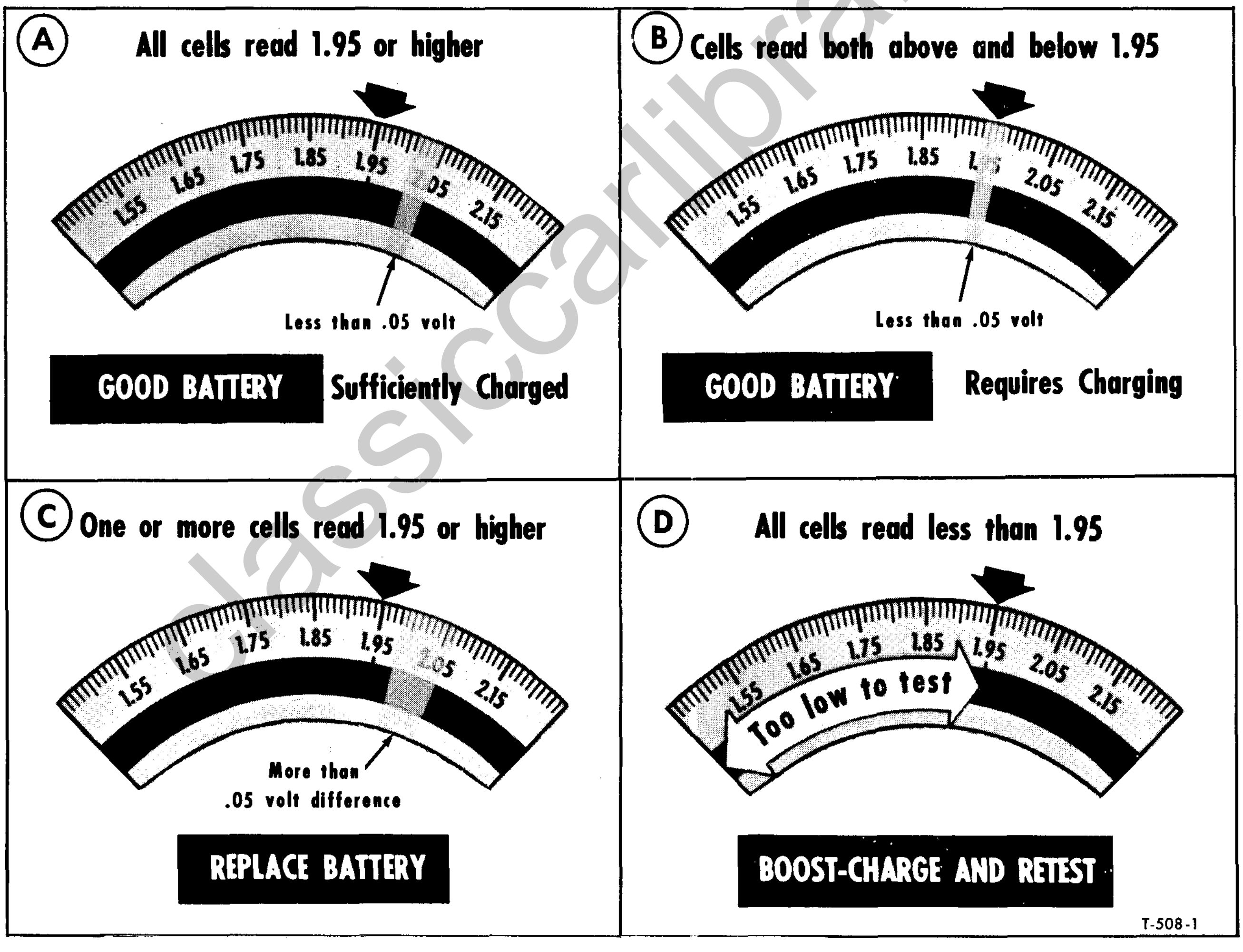


Figure 3—Battery Light Load Test

"Boost Charging For Light Load Test.") If battery is found to be good after boosting, it should be fully recharged for good performance. If none of the cells come up to 1.95 volts after the first boost charge, the battery should be given a second boost. Batteries which do not respond after a second boost charge should be replaced.

NOTE: If any battery found to be good by the "Light Load Test" does not perform satisfactorily in subsequent service, it should again be tested by the "Light Load Test" and if it still tests "good" it should be removed from vehicle and tested as outlined under "Full Charge Hydrometer Test."

BOOST CHARGING FOR
THE LIGHT LOAD TEST

Boost charge 12-volt batteries having an ampere hour capacity of 100 or less at 50 amperes for 20 minutes (50 x 20 = 1000 ampere minutes). Boost charge batteries having an ampere hour capacity of over 100 at 60 amperes for 30 minutes (60 x 30 = 1800 ampere hour minutes). If charger will not give this rate, charge for an equal number of ampere minutes at best rate available.

IMPORTANT: For purposes of this test, do not boost battery more than the amount indicated.

CHARGING AFTER THE LIGHT LOAD TEST

For best performance, a good battery should be fully charged before being returned to service.

If batteries are to be fully charged by means of a quick charger, the charge rate must be tapered" (reduced to a safe limit) when the electrolyte temperature reaches 125°F., or when gassing becomes excessive. Failure to do so may harm the battery.

NEW VEHICLES IN STOCK

1. Check electrolyte on each new vehicle received; add sufficient distilled water to bring the electrolyte up to bottom of vent wells.

2. Check electrolyte and add distilled water as necessary at weekly or semi-monthly intervals, depending upon the weather. Warm weather causes greater water loss.

3. If specific gravity of the battery is below 1.215 (corrected to 80°F.), remove the battery from the vehicle and place it on a charging line. Charge the battery until specific gravity reaches 1.260-1.280.

Before a new truck is placed in service, make sure the specific gravity of the battery electrolyte is at least 1.250, preferably higher. Under no circumstances should acid be added to a new battery, to increase the specific gravity of the electrolyte.

CARE OF NEW BATTERIES IN STORAGE

New batteries in storage should be stored and cared for in accordance with instructions furnished by the battery manufacturer.

PREPARING DRY-CHARGED
BATTERIES FOR SERVICE

Electrolyte should be added to dry-charged batteries in accordance with instructions furnished by the battery manufacturer.

INSTALLING BATTERIES

Battery installation varies depending on the truck model and series. To install a battery properly, it is important to observe the following:

1. Connect grounded terminal of battery last to avoid short circuits which may damage the electrical system.

2. Check to be sure there are no foreign objects in the carrier so that the battery will rest properly in the bottom of the carrier.

3. Tighten battery hold-down evenly until snug (60-80 in.-lbs.). Do not draw down tight enough to distort or crack the battery case or cover.

4. Be sure cables are in good condition and that terminal clamps are clean and tight. Make sure battery ground cable is clean and tight at engine block or frame.

5. If a bolt type clamp is used to secure the battery cable to the battery post, push the terminal over the post as far as possible, at least flush with or below top of post. Tighten bolt until terminal is snug with post.

BATTERY SPECIFICATIONS

PART NO.	MODEL NO.	CATALOG NO.	VOLTS	NO. OF PLATES PER CELL	AMP. HR. CAPACITY AT 20 HR. RATE	CRANKING ABILITY AT 0° F.
1980038	E-3000	Y-71	12	11	70	2.0 Min. at 300 Amp.
1980516	2M-516	516	6	17	120	4.5 Min. at 300 Amp.
1980716	4HR-160	716	6	21	160	7.0 Min. at 300 Amp.
1980718	7DR-200	718	6	27	200	10.5 Min. at 300 Amp.
1980760	8DR-205	760	12	27	205	10.5 Min. at 300 Amp.
1980926	3H-926	926	6	21	145	6.0 Min. at 300 Amp.
1980974	9H9-974	974	12	15	85	2.8 Min. at 300 Amp.

STARTING SYSTEM

The standard and optional type starting motors used on vehicles covered by this manual are shown in the "Model Application Chart" following:

STARTING MOTOR MODEL APPLICATION CHART

TRUCK MODELS	ENGINE	STANDARD PART NO.
HM/JM/TM-80	V6-401M	1107376
HV/JV/TV-70	6V-53	1114101
HI/JI-90; FI/DI-90	6-71	1114105 or 1114178
MH-90; FH/DH-90	8V-71	1114074 or 1114143
MI-90	6-71	1114135 or 1114163
HN/JN-90; FN/DN-90	NHC-250	1114074 or 1114143
FC/DC-90	NHTC-270	1114074 or 1114143
		OPTIONAL PART NO.
HM/JM-80.	V6-401M	1107371
HM/JM/TM-80	V6-478M	1107586
HI/JI-90; FI/DI-90	6-71	1114070 or 1114161
HN/JN-90; FN/DN-90	NH-230	1114074 or 1114143
FC/DC-90	NTC-335	1114074 or 1114143

GENERAL DESCRIPTION

A solenoid operated, overrunning clutch type starting motor having an enclosed shift lever is used on all vehicles covered by this manual.

The drive end housing is extended to enclose the entire shift lever mechanism and solenoid plunger. The solenoid flange is mounted on drive end housing with sealing compound used between flange and field frame. A compression type shift lever return spring located inside the solenoid case is used to operate the overrunning clutch. On gasoline engine models, primary circuit to ignition coil is fed from solenoid while starter is operating.

Positive lubrication is provided to bronze bushings in commutator end frame, in drive end housing, and in the nose housing by oil saturated wicks that project through each bushing and contact the armature shaft.

STARTING SYSTEM OPERATION

The starting system consists of the battery, starting motor, including the drive assembly which engages the flywheel ring gear during cranking, the starter solenoid, mounted on the starting motor for shifting the drive assembly and closing the motor circuit, and the ignition or control switch which connects a lead from the battery to the solenoid switch, when in the start position. During cranking, the ignition switch (gasoline engine models) also connects the battery to the coil.

When starter circuit is energized, the solenoid operated shift lever slides the pinion into mesh with the flywheel ring gear teeth. The rotary motion between pinion and ring gear, provided by spiral splines on clutch shaft, normally relieves tooth abutment on the first attempt to engage pinion and ring gear. A protective sleeve located on the spiral spline acts as a stop for the pinion when extreme tooth abutment occurs. This limits the clutch travel, preventing switch contacts in solenoid from closing. Therefore, the armature cannot rotate before pinion is properly engaged, thus preventing damage to pinion and ring gear. A second attempt to engage rotates pinion enough to assure proper engagement.

STARTING MOTOR CIRCUIT TESTS (ON VEHICLE)

Although the starter cannot be checked against specifications on the vehicle, checks can be made for excessive resistance in the starter circuit.

Referring to figure 1 and with starter cranking engine during each check, measure resistance in various parts of the circuit as follows:

IMPORTANT

To prevent engine starting while performing these checks, disconnect primary lead at distributor on gasoline engine models. On diesel engine models, pull stop knob on instrument panel out to set injector racks in NO FUEL position, or disconnect wire from full shut-off solenoid.

CHECK V-1 (Fig. 1, View A)

Check V-1 with voltmeter leads connected to battery positive (+) post and the battery terminal on the starter solenoid. On vehicles equipped with a solenoid and a magnetic switch, connect voltmeter leads as noted above, then connect voltmeter leads to battery positive (+) post and the battery terminal on the magnetic switch.

CHECK V-2 (Fig. 1, View B)

Check V-2 with voltmeter leads connected to battery terminal and to motor terminal on solenoid. On vehicles equipped with a solenoid and a magnetic switch, connect voltmeter leads as noted previously, then connect voltmeter leads to battery terminal and to motor terminal on magnetic switch.

CHECK V-3 (Fig. 1, View C)

Check V-3 with voltmeter leads connected to battery negative (-) post and the starter field frame.

CHECK V-4 (Fig. 1, View C)

On vehicles equipped with a solenoid and a magnetic switch, check V-4 with voltmeter leads connected to motor terminal on magnetic switch and to battery terminal on starter solenoid.

If voltmeter reading in any of the above checks exceeds 0.5 volt, excessive resistance is indicated in the part of the circuit being checked. Locate and eliminate the cause of excessive voltage drop in these circuits in order to obtain maximum efficiency from the starting system. Cause of excessive resistance may be loose, corroded, or dirty connections, or frayed cables.

If starter fails to crank engine, first make sure battery is not discharged, then check solenoid or magnetic switch operation. If the solenoid fails to operate, the trouble may be due to excessive resistance in the starter control circuit. Check all wiring and connections from ignition or control switch to solenoid for loose or corroded connections. If the cause of excessive resistance is not apparent, connect a short jumper lead across the solenoid battery and switch terminals. If solenoid operates with jumper lead connected, trouble is in the control circuit. Check for defective ignition or control switch. If solenoid does not operate with jumper lead connected, solenoid or magnetic switch is defective and must be replaced.

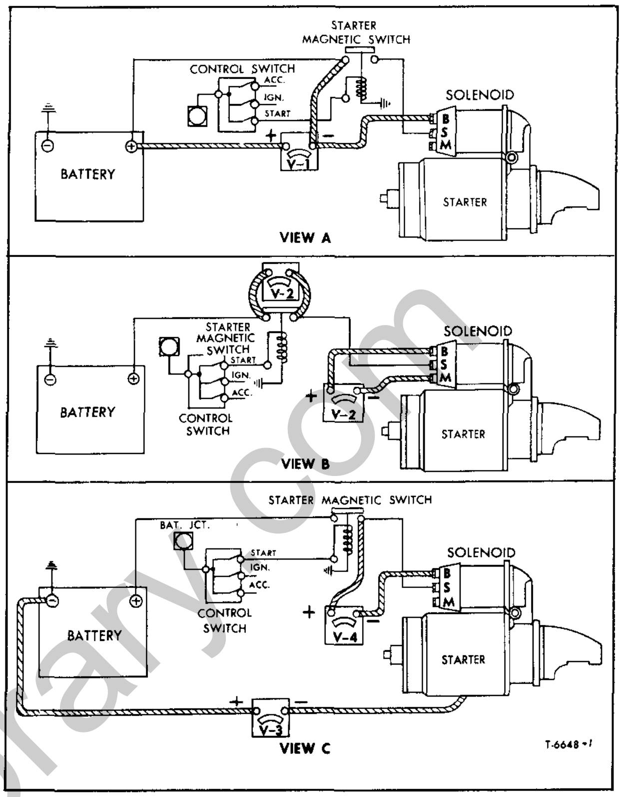


Figure 1—Voltmeter Connections for Checking Circuits

STARTER REPLACEMENT

REMOVAL

1. Remove ground strap from battery negative (-) post or tape end of battery cable when disconnected from starter solenoid to prevent discharge of battery by direct short.
2. Disconnect all wires from starter solenoid terminals.
3. Remove bolts, nuts, and washers attaching starter to flywheel housing and pull starter forward to remove.

INSTALLATION

1. On all vehicles equipped with the Toro-Flow Diesel engine, position spacer between flywheel housing and starting motor, then install starter to flywheel housing mounting bolts and washers. Tighten bolts to torque recommended in "Specifications" at end of this section.

On all other engine models, position starter against flywheel housing and secure with bolts, nuts, and washers. Tighten starter to flywheel housing mounting bolts or nuts to torque recommended in "Specifications" at end of this section.

2. Connect all wires to starter solenoid terminals referring to proper wiring diagram in applicable "Wiring Diagrams" booklet to make sure of proper connections. Tighten terminal nuts firmly.

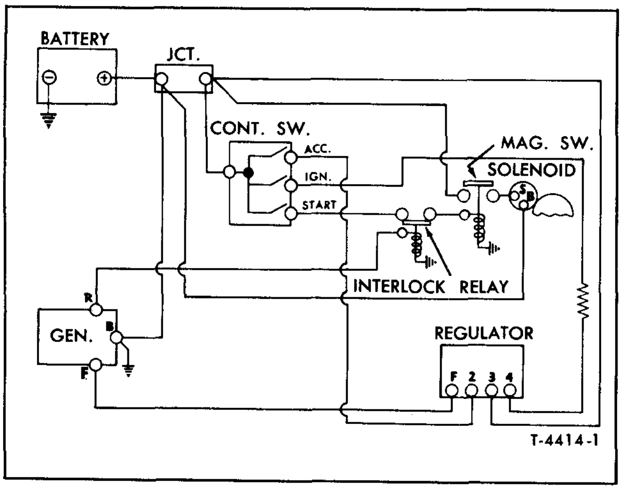


Figure 2—Starter Automatic Disengagement and Lock-Out (NH230, NHC250 Engines)

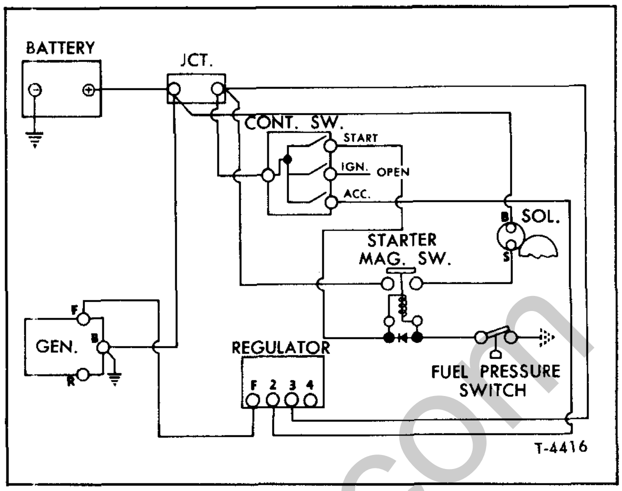


Figure 3—Starter Automatic Disengagement and Lock-Out (6V-53, 6-71, 8V-71 Diesel Engines) (Typical)

3. Connect ground strap to battery negative (-) post.

STARTER AUTOMATIC DISENGAGEMENT AND LOCK-OUT

A starter automatic disengagement and lock-out system is used on all series "53" and "71" Diesel engine models, and on all Cummins diesel engine models.

This system is used to prevent starter over-speeding by breaking circuit between the battery and starter solenoid after engine is started and to prevent starter pinion from engaging a running flywheel by keeping the battery-to-starter solenoid circuit open while engine is running. With battery-to-starter solenoid circuit broken, the starter will automatically disengage if control switch is not released after the engine is started.

NOTE: A resistance wire in the field circuit, on some vehicles, limits generator output during cranking until the engine reaches a predetermined speed.

NH-230, AND NHC-250 ENGINES

A typical interlock system used on vehicles equipped with the V8 gasoline engine, the Toro-Flow II Diesel engine and Cummins NH-230 or NHC-250 engines is shown in figure 2. When control switch is placed in "START" position, current from the battery is supplied through the control switch and starter interlock relay to energize the starter magnetic switch coil winding. With windings energized, switch contacts will close to complete circuit to starter solenoid. With solenoid energized, starter will operate. When engine is started, current from generator "R" terminal will flow through the interlock relay coil windings. With windings energized, interlock relay contacts will open to break circuit between the battery and starter magnetic switch.

SERIES "53" AND "71" DIESEL ENGINES

A typical system used on vehicles equipped with the Series "53" and "71" Diesel engine is shown in figure 4. When the control switch is turned to "START" position, current from the battery will flow through the control switch and starter magnetic switch coil windings to ground through the engine fuel pressure switch.

NOTE: A diode is spliced into the engine wiring harness (fig. 3) to protect the fuel pressure switch contacts.

With the starter magnetic switch coil winding energized, switch contacts will close to complete circuit to starter solenoid. With solenoid energized, starter will operate. When engine is started, the fuel pressure switch contacts will open to break ground circuit to the starter magnetic switch. The starter magnetic switch contacts will then open to break circuit between the battery and the starter solenoid.

SERIES DC/DN/FC/FN-90 (WITH CUMMINS DIESEL ENGINE)

A typical system used on vehicles equipped with the integral type generating system (generator with regulator built in) is shown in figure 4.

When control switch is placed in "IGN" position and "START" switch is energized, current will

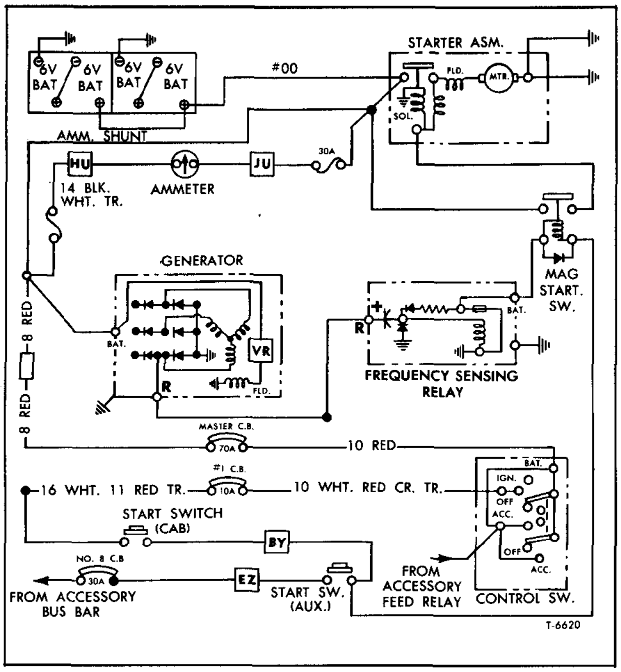


Figure 4—Starter Automatic Disengagement and Lock-Out (DC/DN/FC/FN90) (Typical)

flow through starter magnetic switch coil windings and frequency sensing relay contact points to ground. With windings energized, the magnetic switch contacts close to complete circuit from battery to

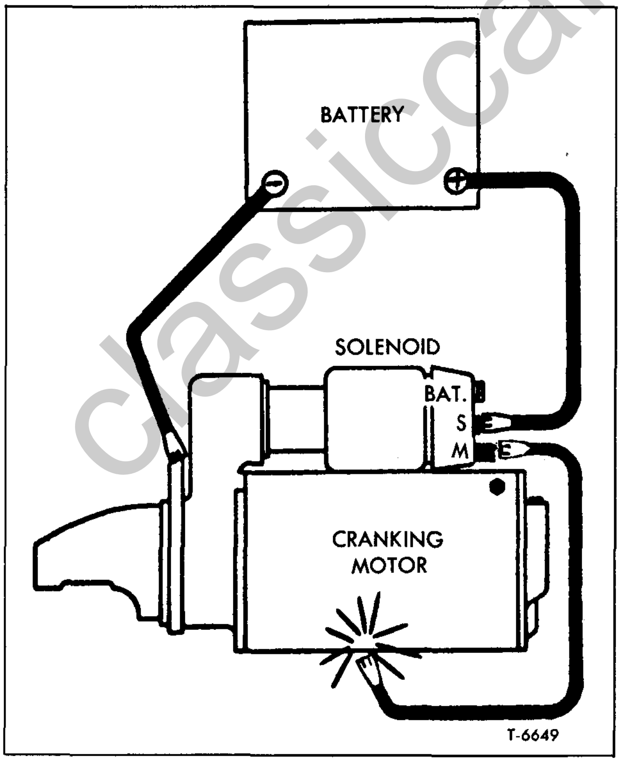


Figure 5—Circuit for Checking Pinion Clearance

starter solenoid operating coil. With solenoid energized, starter will operate.

When engine is started, current from generator "R" terminal will flow through frequency sensing relay condenser and operating coil causing relay contacts to open, thus breaking the circuit between the battery and starter magnetic switch.

NOTE: The condenser and resistor in the frequency sensing relay will determine at what frequency the relay contacts will open.

PINION CLEARANCE CHECK

LIGHT AND INTERMEDIATE DUTY

1. The drive pinion clearance should be checked whenever starter has been overhauled. There is no means of adjusting the pinion clearance on the light duty starting motors. If clearance is not within specified limits, it may indicate excessive wear of the solenoid linkage or shift lever yoke lugs. Clearance between the end of the pinion and pinion stop (retainer), with pinion in cranking position, should be 0.010"-0.140". Check as follows:

a. Connect a voltage source of approximately 6 volts between the solenoid switch terminal (S) and ground.

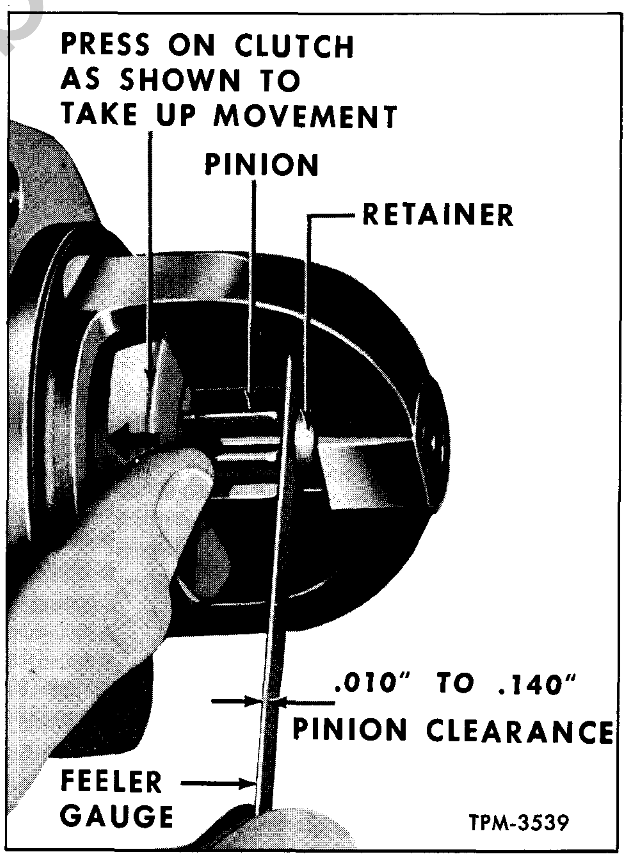


Figure 6—Measuring Pinion Clearance (Light and Intermediate Duty) (Typical)

b. IMPORTANT: DO NOT connect the voltage source to ignition coil terminal (R) of the solenoid. Do not use a 12-volt battery in place of the 6 volts specified as this will cause the motor to operate. As a further precaution to prevent motoring, connect a heavy jumper lead from the solenoid motor terminal to ground (see fig. 5).

c. After energizing the solenoid with the clutch shifted forward, push the pinion back toward the commutator as far as necessary to take up any possible slack, then check the clearance with a feeler gauge as shown in figure 6. If not within 0.010" to 0.140", disassemble and replace worn parts in solenoid and shift lever linkage.

HEAVY DUTY

The pinion clearance on the heavy duty overrunning clutch type starting motors is checked in the same manner as the light duty starting motors except the pinion clearance is adjustable and the dimensions are different.

1. Accomplish steps under light duty starting motors "Pinion Clearance Check" necessary to energize solenoid and shift clutch forward. This may take a 12-volt battery, if so, use one.
2. Press on clutch to take up movement and measure distance from outer edge of pinion to inner edge of nose housing. See figure 7. Dimension should be 23/64 - 1/32-inch.
3. If clearance is incorrect, remove plug and adjust clearance by rotating nut clockwise to decrease clearance or counterclockwise to increase.

STARTER SOLENOID

Starter solenoid is used to shift the starter drive pinion into engagement with flywheel teeth and to complete the circuit from battery to starter.

Solenoid has two windings, the pulling winding and the holding winding. When ignition switch is turned to "START" position both windings are energized, producing a magnetic field which pulls the plunger in. Inward movement of plunger shifts starter pinion into engagement with flywheel ring gear teeth, and closes the main contacts in the solenoid switch to complete the circuit from battery to starter.

The pulling winding draws comparatively heavy current for a short interval. This is required to shift the pinion into engagement. The holding winding also aids the pulling winding. As soon as plunger closes the main switch contacts, pulling winding is de-energized and only the holding winding draws current for the balance of the starting cycle.

SOLENOID MAINTENANCE

Solenoids require no periodic maintenance other than keeping the terminals clean and tight. Always check action of solenoid if it has been removed. If unit fails to function, first check wiring before condemning the solenoid. Solenoid windings can be checked for current draw, open circuit, or shorts. Refer to "Specifications" at end of this section for current values. Solenoid coil, terminals, and switch plunger can be replaced if burned or otherwise damaged. Whenever solenoid is replaced on overrunning clutch type starting motors, pinion clearance must be checked and adjusted, as previously directed under "Pinion Clearance Check."

STARTER MAGNETIC SWITCH

Switch is used to make and break the battery-to-starter circuit. When control switch is turned to "START" position, windings in magnetic switch are energized; this causes switch contacts to close, completing circuit from battery to starter. When control switch is released, spring in switch causes contacts to open. Switch requires the same maintenance described above for "Starter Solenoid" except that there is no linkage adjustment.

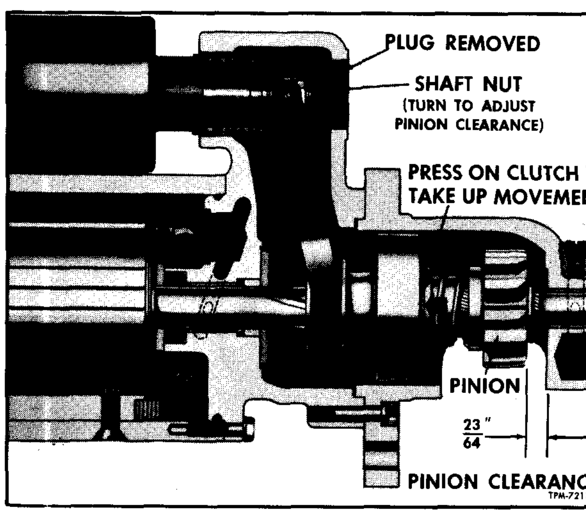


Figure 7 —Measuring Pinion Clearance (Heavy Duty)

STARTING SYSTEM SPECIFICATIONS

STARTER MODEL MAKE	1107371 (a) DELCO-REMY	1107376 (a) DELCO-REMY	1107586 (a) DELCO-REMY	1114070 (b) 1114074 (b) 1114143 (b) 1114161 (b) DELCO-REMY	1114101 (b) 1114121 (b) 1114135 (b) 1114163 (b) DELCO-REMY	1114105 (b) 1114178 (b) DELCO-REMY
Type of Drive	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch	Overrunning Clutch
Rotation (Viewing Drive End)	CW	CW	CW	CW	CW	CW
No Load Test						
Volts	9	9	9	11.0	9	9
Minimum Amps	55*	55*	50*	115*	120*	120*
Maximum Amps	75*	85*	80*	170*	150*	150*
Minimum RPM	6700	3000	5500	6300	3000	3000
Maximum RPM	9500	4800	9000	9500	4500	4500
Starter Solenoid						
Model No.	1114359	1114359	1114356	1119879	1119862	1119879
Rated Voltage	12	12	12	12	12	12
Current Consumption						
Pull-In Winding						
Amps	13.5-15.5	13.5-15.5	13.5-15.5	—	—	—
Volts	5	5	5	—	—	—
Both Windings						
Amps	—	—	—	65.3-73.3	65.3-73.3	65.3-73.3
Volts	—	—	—	10	10	10
Hold-In Winding						
Amps	14.5-16.5	14.5-16.5	14.5-16.5	12.7-14.3	12.7-14.3	12.7-14.3
Volts	10	10	10	10	10	10

* Includes solenoid.
(a) Pinion clearance 0.010″-0.140″
(b) Pinion clearance $\frac{23}{64}$″ plus or minus $\frac{1}{32}$″.

FREQUENCY SENSING RELAY

Make	Delco-Remy
Model No.	1115872

STARTER INTERLOCK RELAY

Make	Delco-Remy
Model No.	1115848
Point Opening (In.)	0.017-0.033
Opening Voltage Range	3.7-5.2

STARTER MAGNETIC SWITCH

Make	Delco-Remy	Delco-Remy
Model	001466	1119828
Rated Voltage	12	12
Current Consumption		
Both Windings		
Amps	2.1-2.3	2.1-2.4
Volts	8	8

STARTING SYSTEM TORQUE SPECIFICATIONS

ITEM	TORQUE (FT. LBS.)
Starter-To-Flywheel Housing Bolt	
V-6 Gasoline Engine Models	25-35
6-71 Diesel Engine Models	90-110
6V-53 Diesel Engine Models	
Except TV-70	80-90
TV-70 (only)	110-160
6V-71 or 8V-71 Diesel Engine Models	110-160

IGNITION SYSTEM

GENERAL

The ignition system consists of the source of power (battery or generator) ignition switch, ignition coil, distributor, condenser, spark plugs, and high and low tension wires.

A 1.52 OHM resistance wire is installed in the engine wiring harness on all vehicles equipped with the V6 gasoline engine. This wire is installed between the battery or ignition terminal on the ignition switch and the (+) terminal on the ignition coil and is identified on Wiring Diagrams in applicable "Wiring Diagrams" as 20-WHT.-ORN. & PPL. CR. TR.

The resistance wire is used to increase ignition coil efficiency and lengthen distributor point life. If resistance wire becomes damaged, replace with wire of same gauge and length.

IMPORTANT: DO NOT use regular copper wire in place of the resistance wire. When replacing a resistance unit, use recommended parts.

NOTE: Resistance value of the wire or unit can be checked as explained later in this section.

CAUTION

Since the ignition coil is fed through the starter solenoid during cranking, the engine will have a tendency to start whenever it is cranked, even though the ignition switch is in the "OFF" position. To prevent this from happening and possibly causing serious injury, always disconnect the primary wire from the ignition coil before performing tests which require cranking the engine.

RESISTANCE WIRE OR UNIT CHECK

IMPORTANT: Before testing the resistance wire or unit, make sure the ignition switch is in the "OFF" position, otherwise damage to ohmmeter will result.

1. Make sure ignition switch is in "OFF" position.
2. Connect an ohmmeter lead to each end of the resistance wire or unit and note reading.
3. If ohmmeter reading is not within 1.45 - 1.59 OHMS, replace the resistance wire or unit.

IGNITION MAINTENANCE

Inspecting and adjusting the ignition system at regular intervals will aid in locating and correcting conditions which result in lowered performance before the engine performance is seriously affected.

1. Check condition of battery and cables as directed in "BATTERY" section.
2. Check operation of centrifugal advance mechanism by removing distributor cap and turning the rotor in clockwise direction. The cam should rotate freely and when released, it should return to its original position without sticking or binding.
3. Wipe out distributor cap with a soft cloth and clean wire sockets with a small round brush. Inspect cap and rotor for chips, cracks, and carbonized short paths; look for burned metal inserts in cap and for burned metal segment on rotor.
4. Inspect breaker points. Slight discoloration and roughness is normal. Slight roughness can be removed with a few strokes of a clean, fine-cut contact file. If points are badly pitted or burned, replace points as directed later under "Distributor."
5. Check cam dwell angle with a dwell meter. If dwell meter is not available, point opening can be checked with a dial indicator. Never check opening of used points with a feeler gauge. If dwell angle (or point opening) requires adjustment, adjust as directed later under "Distributor."
6. Check ignition timing with timing light as directed later under "Ignition Timing."
7. Inspect all ignition wiring for brittle, cracked, or oil-soaked insulation. Check all connections, making sure they are clean and tight.
8. Distributor must be kept properly lubricated. Refer to LUBRICATION (SEC. 0) of this manual, for intervals and instructions.
9. Remove spark plugs and clean, inspect, and adjust point gap as directed later under "Spark Plugs."

IGNITION SWITCH REPLACEMENT

The ignition or control switch and harness-to-switch connector features a three tang lock to secure a firm connection (fig. 1). The switch lock cylinder and cylinder housing can be removed as follows:

REMOVAL

NOTE: On conventional cab and Series 70-80 Tilt cab models, it may be necessary to remove instrument cluster retaining screws and tilt cluster outward to gain access to ignition or control switch.

On series 90 Alum. Tilt Cab vehicles, remove access panel from console to gain access to control switch.

1. Disconnect negative (-) cable from battery post.

2. Remove lock cylinder by positioning switch in "OFF" position and inserting wire in small hole in cylinder face. Push in on wire to depress plunger, then turn key counterclockwise until lock cylinder can be pulled from cylinder housing.

3. Remove the metal ignition or control switch retaining nut from passenger side of dash panel using a suitable tool.

4. Pull ignition or control switch from dash panel and separate wiring connectors by inserting the thin blade of a small screwdriver under each tang of wiring connector as shown in figure 1. Pull connector from switch.

INSTALLATION

1. Engage lock tangs of wiring connector with mating connector on ignition or control switch. Make sure tangs are fully engaged.

2. On conventional cab and Series 70-90 tilt cab models, tilt instrument cluster outward, then position switch with wiring connected into dash panel opening and install switch retaining nut firmly.

On series 90 Alum. Tilt Cab vehicles, insert switch with wiring connected through access opening in console then install switch retaining nut and tighten firmly.

3. Insert switch lock cylinder into switch housing and rotate clockwise to secure in the lock position.

4. Connect negative battery cable to battery.

5. Install instrument cluster retaining screws or console access panel if removed.

IGNITION TIMING

Timing the Ignition System Comprises:

(1) Initial Timing -- Setting distributor to permit opening of points at correct firing intervals
- and -

(2) Manual Advance Adjustment -- Retarding or advancing the point opening to compensate for various grades of fuel which may be used. These timing factors require checking and adjusting at regular intervals, or whenever performance of engine necessitates such action.

IMPORTANT: Before attempting to adjust ignition timing, make sure carburetor is properly adjusted. Disconnect vacuum line from distributor vacuum advance unit and plug open end of line.

NOTE: The following timing settings are recommended settings for average nation-wide regular gasoline. Timing must be retarded as required when lower octane gasoline is used.

WITH ENGINE RUNNING

NOTE: Make sure distributor is in good condition and dwell angle is properly adjusted before

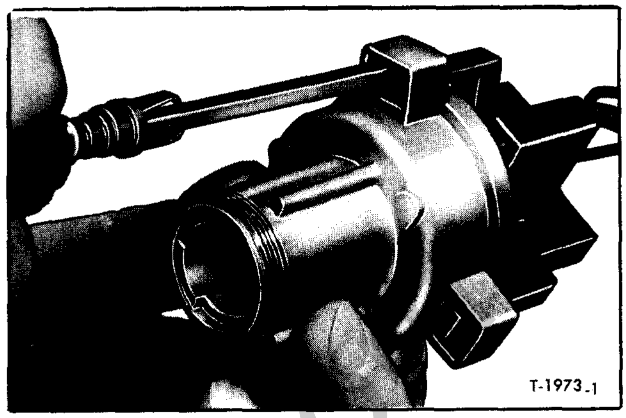


Figure 1—Disengaging Ignition Switch Connector

checking ignition timing. If dwell angle requires adjustment, adjust as directed later under "Distributor."

1. Figure 2 shows location of timing marks on crankshaft pulley hub of the V6 engines. Connect one lead of a timing light to No. 1 spark plug terminal (front plug on left side) and connect the other lead in accordance with instructions furnished with the instrument.

2. Start engine and run at idle.

3. Set timing to 10 degrees before upper-dead-center (BUDC). If timing mark does not align with pointer, loosen distributor mounting clamp cap screw (fig. 4 or 5) and rotate distributor body as required to synchronize timing light flashes with timing mark on engine crankshaft pulley.

4. Tighten distributor mounting clamp cap screw after adjustment is made.

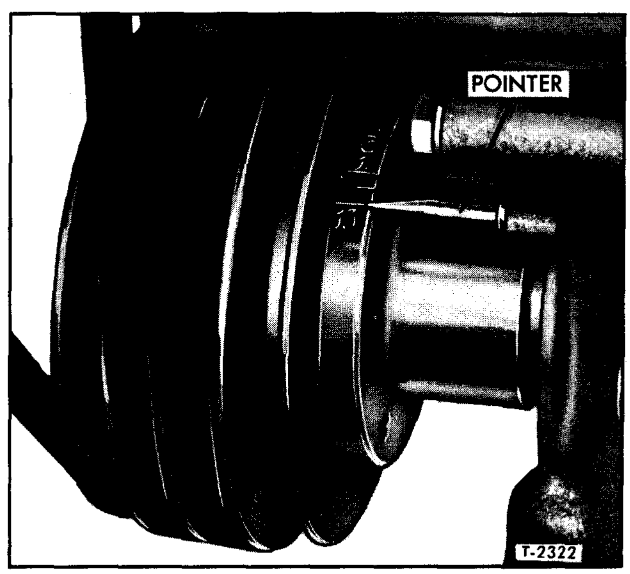


Figure 2—Timing Marks (V6 Engine) (Typical)

WITH ENGINE NOT RUNNING

1. Locate No. 1 cylinder spark plug wire on distributor cap. Mark distributor body adjacent to No. 1 wire socket in cap. Remove the distributor cap.

2. Intermittently operate starter until proper timing mark on crankshaft pulley is aligned with pointer (fig. 2).

With pointer and timing mark aligned, rotor segment should point toward the mark made on distributor body in previous Step 1. Instead, segment may point 180 degrees away from mark; in this case engine must be rotated one complete revolution and timing mark realigned.

3. With timing mark and pointer aligned and with rotor segment pointing to No. 1 spark plug wire, points should just begin to open. Loosen distributor mounting clamp cap screw and turn the distributor housing clockwise until points close. Remove high tension wire from center socket in distributor cap. Turn on ignition switch and hold end of high tension wire (still connected to coil) ¼-inch from a ground; then turn distributor housing counterclockwise until a spark jumps the gap between high tension wire and ground. When spark occurs, points are open. Hold distributor in this position and tighten mounting clamp cap screw. Turn ignition switch off and install distributor cap. Install high tension wire in center socket in cap.

MANUAL ADVANCE ADJUSTMENT

1. After engine has been thoroughly warmed up, drive vehicle using grade of fuel expected to be used in service. Engine should not ping or knock excessively under load and full throttle.

2. If knock is evident, loosen distributor mounting clamp cap screw (fig. 4) and turn distributor housing clockwise to retard spark until knock is eliminated.

NOTE: Manual advance should be set to obtain the best possible engine performance with the particular grade of gasoline being used.

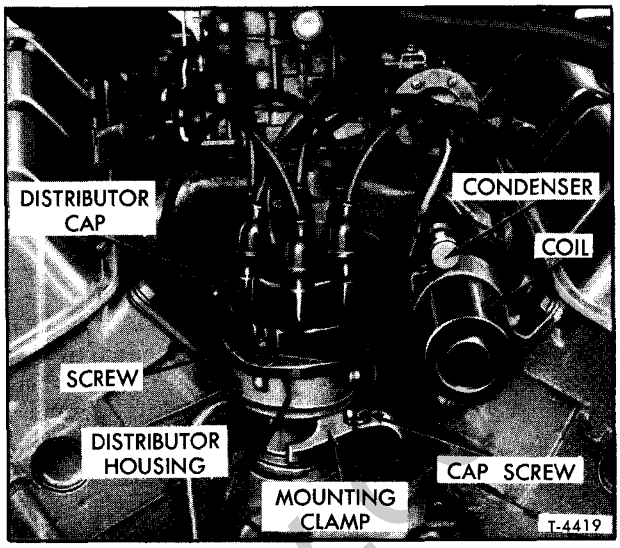


Figure 3—Distributor and Ignition Coil Installed (V6 Engine) (Typical)

DISTRIBUTOR

Distributor is mounted on top center of cylinder block at rear of engine and is driven from the engine camshaft by means of spiral cut gears. A gasket is used between the distributor housing flange and the cylinder block. A mounting clamp and cap screw is used to hold the distributor securely in place (fig. 4), and a drive gear, on lower end of the distributor shaft, has a hexagonal opening in the lower end which engages the oil pump shaft to drive the oil pump. The model number is stamped on the distributor housing.

CONTACT POINT REPLACEMENT (V-6 ENGINE)

REMOVAL

1. Remove screws which attach distributor cap to housing, then remove distributor cap.

2. Remove the rotor.

3. Pull primary and condenser lead wires from contact point quick-disconnect terminal (fig. 4).

4. Remove contact set attaching screw; lift point set from breaker plate.

5. Clean breaker plate of oil, smudge, and dirt.

INSTALLATION

NOTE: The service replacement contact set has the breaker lever spring and the point alignment preadjusted. Only the dwell angle requires adjustment after replacement.

1. Place new contact set assembly on breaker plate and install attaching screw.

IMPORTANT: Carefully wipe protective film from contact set prior to installation.

NOTE: Pilot on contact set must engage matching hole in breaker plate.

2. Connect primary lead and condenser lead

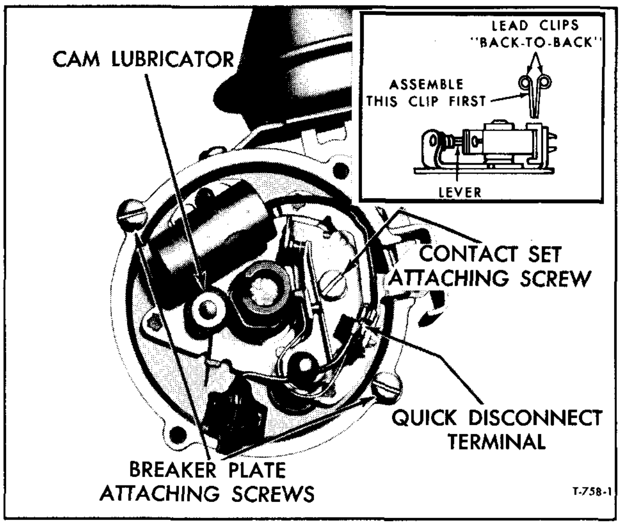


Figure 4—Breaker Plate Attaching Parts (V6 Engine)

to terminals (fig. 4). Lead clips must be assembled "back-to-back." Push clip nearest the contact lever down between the spring and locator, then push the remaining clip down between the first clip and locator. Do not push on the spring.

3. Apply a slight trace of petroleum jelly to the breaker cam and a few drops of S.A.E. #20 oil on top of the shaft.

4. Check and adjust points for proper alignment and breaker arm spring for proper tension (fig. 5). Use an alignment tool to bend stationary contact support if points need alignment.

NOTE: The contact point pressure must fall within specified limits. Weak tension will cause chatter resulting in arcing and burning of the points and an ignition miss at high speed, while excessive tension will cause undue wear of the contact points, cam and rubbing block. Breaker arm spring tension should be 19-23 ounces. The contact point pressure should be checked with a spring gauge. The scale should be hooked to the breaker lever and the pull exerted at 90 degrees to the breaker lever as shown in figure 5).The reading should be taken just as the points separate. The pressure can be adjusted by bending the breaker lever spring. If pressure is excessive, it can be decreased by pinching the spring carefully. To increase pressure, the lever must be removed from the distributor so the spring can be bent away from the lever. Avoid excessive spring distortion.

5. Set point opening to dimension listed in "Specifications" at end of this section.

6. Install rotor, then position and secure the distributor cap to housing.

SETTING DWELL ANGLE

The point opening of new points can be checked

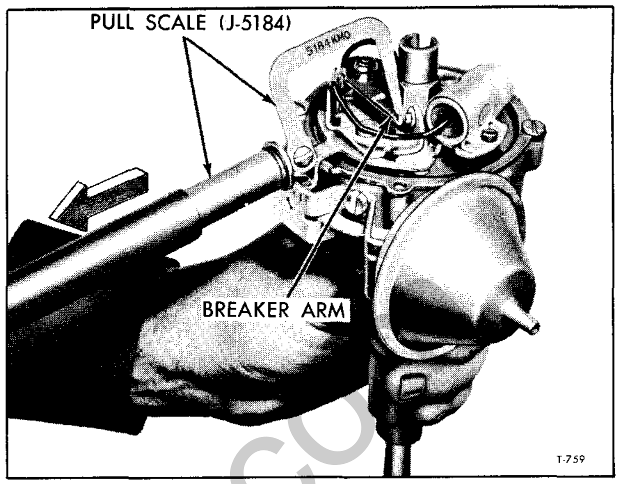


Figure 5—Checking Breaker Arm Spring Tension (V6 Engine)

with a feeler gauge, but the use of a feeler gauge on rough or uncleaned used points is not recommended since accurate mechanical gauging cannot be done on such points.

Contact points must be set to the proper opening. Points set too close may tend to burn and pit rapidly. Points with excessive separation tend to cause a weak spark at high speed. Proper point setting for these engines are listed in "Specifications" at end of this section.

New points should be set to the larger opening as the rubbing block will wear down slightly while seating to the cam. Contact points should be cleaned before adjusting if they have been in service.

CONTACT POINT OPENING
ADJUSTMENT (V6 ENGINES)

1. Release distributor cap hold-down screws, remove cap and place it out of work area.

2. Check alignment of contact points. Do not bend the breaker lever. Do not attempt to align used points; replace them where serious misalignment is observed.

3. Turn the distributor shaft until the breaker arm rubbing block is on the high point of the cam lobe. This will provide maximum point opening.

4. Loosen the contact support lock screw.

5. Use a screwdriver to move point support to obtain a 0.019" opening for new points (0.016" opening for used points) (fig. 6).

6. Tighten the contact support lock screw and recheck the point opening.

7. After checking and adjusting the contact point opening to specifications, the cam angle or dwell should be checked with a dwell meter, if such equipment is available (see "Specifications" at end of section for proper dwell angle).

NOTE: DISCONNECT AND PLUG VACUUM LINE WHEN CHECKING. If the cam angle is less than the specified minimum, check for defective or misaligned contact points or worn distributor cam lobes. The variation in cam angle readings between idle speed and 1750 engine rpm should not exceed three degrees. Excessive variation in this speed range indicates wear in the distributor.

NOTE: Cam angle readings taken at speeds above 1750 engine rpm may prove unreliable.

CENTRIFUGAL ADVANCE

V6 ENGINES

Distributor is equipped with centrifugal spark advance mechanism. Where speed variations are encountered, spark advance, based on engine speed, is necessary to develop maximum power. Centrifugal advance mechanism is located under the breaker plate assembly, and is a part of the shaft assembly. It consists of an automatic cam actuated by two centrifugal weights controlled by springs.

As engine speed increases, the weights gradually throw out and rotate the cam to provide the desired spark advance for speed at which engine is running. The correct weights, cam contour, and spring calibration have been selected to provide spark advance which will give the best performance of engine throughout its entire speed range. Centrifugal advance mechanism can be checked for freeness of operation as previously directed under "Ignition Maintenance." A distributor tester must be used to check advance action under various speed conditions.

VACUUM ADVANCE

The vacuum advance control unit is mounted to the base of the distributor housing. The vacuum

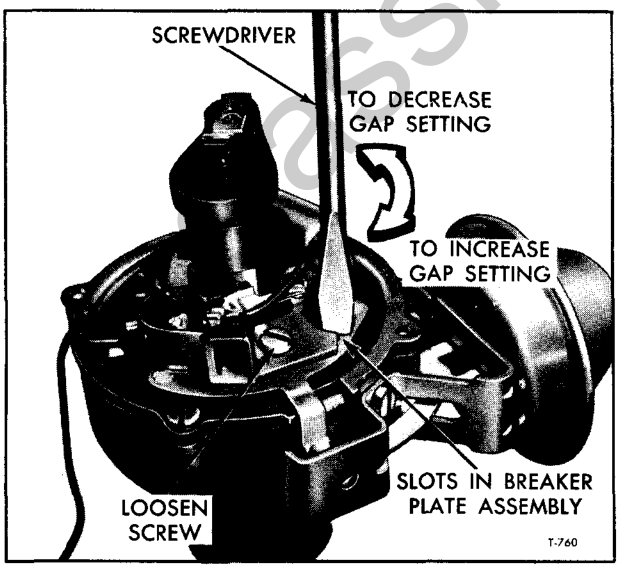


Figure 6 —Setting Point Opening (V6 Engine)

control unit consists of an enclosed, calibrated, spring-loaded diaphragm and is linked to the movable breaker plate. Under part throttle operation, the intake manifold vacuum is sufficient to actuate the vacuum control diaphragm and cause the breaker plate to move, advancing the spark and increasing fuel economy. During acceleration or when engine is under heavy load, the vacuum is not sufficient to actuate the diaphragm and the breaker plate is held in the retarded position by a calibrated return spring which bears against the vacuum diaphragm.

DISTRIBUTOR REMOVAL (V6 ENGINE)

1. Locate No. 1 cylinder spark plug wire on distributor cap; mark this position on cap and mark distributor housing adjacent to No. 1 wire.
2. Release distributor cap hold-down screws, then remove cap.
3. Disconnect the distributor primary wire from terminal on ignition coil.
4. Intermittently operate starter until the crankshaft pulley comes to rest with the 10° BUDC mark aligned with pointer (fig. 2). With pointer and timing mark aligned, rotor segment should point toward mark made on distributor body in Step 1 above. Instead, rotor segment may point 180 degrees away from mark; in this case, rotate engine one complete revolution and realign timing mark with pointer.

NOTE: Distributor can be removed and readily reinstalled if engine remains in this position.

5. Disconnect vacuum line from distributor, then remove cap screw and mounting clamp (fig. 3). Lift distributor straight up until spiral gear disengages camshaft gear. Rotor will rotate a few degrees clockwise as gears disengage. Mark this position of rotor on distributor housing, also note position of vacuum advance mechanism relative to engine. Lift distributor straight up to complete removal. Remove distributor flange to cylinder block gasket.

NOTE: Always set distributor in upright position so oil from distributor shaft will not run out onto the breaker plate and points.

DISTRIBUTOR INSTALLATION (V6 ENGINE)

IF ENGINE HAS NOT BEEN CRANKED

1. If distributor is new, No. 1 firing position can be determined by the mark made on the old distributor housing prior to removal. Also, locate mark made on housing after gears were disengaged.
2. Place new distributor to cylinder block

gasket on block, and lubricate distributor drive gear with engine oil.

3. Turn rotor so segment points to the mark made after disengaging gears. As distributor is inserted into place, spiral gear will cause rotor to turn counterclockwise. It may be necessary to insert the assembly several times to find the correct position to bring rotor segment to No. 1 firing position. Perform Steps 3, 4, and 5 under "If Engine Has Been Cranked" following:

IF ENGINE HAS BEEN CRANKED

1. Remove left-hand valve rocker arm cover. Turn engine over by intermittently operating starter and observe movement of No. 1 intake valve (second valve from front). When intake valve starts to close (raise up), continue to turn engine slowly until pointer on timing gear cover is at proper timing mark on crankshaft pulley (fig. 2). Engine is then in No. 1 firing position.

2. Install distributor as described in Step 1 previously. It may be necessary to turn the oil pump drive shaft to permit engagement of drive shaft with distributor drive gear.

3. Install distributor hold-down clamp and cap screw.

4. Install distributor cap. Install spark plug wires in cap in correct firing sequence -- 1-6-5-4-3-2 on V6 engines -- starting with No. 1 wire in socket adjacent to No. 1 firing position mark on distributor housing, then proceeding clockwise around the cap. Install secondary wire from ignition coil in center socket in distributor cap. Connect distributor primary wire to negative (-) terminal on ignition coil.

5. Check and adjust ignition timing as previously directed under "Ignition Timing."

DISTRIBUTOR CONDENSER

Condenser, mounted on breaker plate and connected across the points, reduces point arc by its ability to store up electrical energy.

REMOVAL AND INSTALLATION

1. Release distributor cap hold-down screws, remove cap, and place it out of the work area.

2. Remove rotor.

3. Disconnect condenser lead wire from contact point quick-disconnect terminal.

4. Remove condenser attaching screw, lift condenser from breaker plate, and wipe breaker plate clean.

5. Install new condenser, using reverse of the procedure outlined above.

TEST

Four factors affect condenser operation, and each must be considered in making tests:

Breakdown. Breakdown is a failure of insulating material, causing direct short between metallic elements of condenser. This condition prevents any condenser action.

Low Insulation Resistance. This condition permits leakage which prevents condenser from holding its charge. A condenser with low insulation resistance is said to be weak.

High Series Resistance. This is excessive resistance in condenser circuit due to broken strands in condenser lead or to defective connections. This will cause burned contact points and ignition failure upon initial start and at high speeds.

Capacity. Capacity is built into a condenser and is determined by the area of the metallic elements, and the insulating and impregnating materials. A condenser of incorrect capacity will result in point pitting.

IGNITION COIL

Ignition coils are mounted on top of block near front of distributor (fig. 3). Ignition coil primary terminals are marked positive (+) and negative (-).

Wire from distributor primary terminal (black) must be connected to the negative (-) terminal of coil. The light green feed wire from starter solenoid and the special resistance wire must be connected to the positive (+) terminal of coil.

IGNITION COIL TEST

If there is any doubt as to the condition of the coil, it should be tested with conventional coil tester, following instructions furnished by manufacturer of testing equipment. Defects indicated by test are:

1. Open primary circuit.
2. Open secondary circuit.
3. Shorted turns in primary or secondary.
4. High voltage breakdown in secondary.
5. High resistance in primary connections.

If any of the above conditions are evident, coil must be replaced.

SPARK PLUGS

GENERAL INFORMATION

Spark plug life is governed to a large extent by operating conditions, and plug life varies accordingly. To insure peak performance, spark plugs should be checked, cleaned, and regapped every 5,000 miles.

Worn and dirty plugs may give satisfactory operation at idling speed, but under operating conditions they frequently fail. Faulty plugs are evident in a number of ways, such as wasting gas, power loss, loss of speed, hard starting, and general poor engine performance.

Spark plug failure, in addition to normal wear, may be due to dirty or leaded plugs, excessive gap, or broken insulator.

Dirty or leaded plugs may be evident by black carbon deposits, or red, brown, yellow, or blistered oxide deposits on the plugs. The black deposits are usually the result of slow speed driving and short runs where sufficient engine operating temperature is seldom reached. Worn piston rings, faulty ignition, over-rich fuel mixture and spark plugs which are too "cold" will also result in carbon deposits. Red, brown, or yellow oxide deposits, a consequence of the combustion of leaded fuel, usually result in spark plug failure under severe operating conditions.

The oxides have no adverse affect on plug operation as long as they remain in a powdery state. But, under high speed or hard pull, the powder oxide deposits melt and form a heavy glaze coating on the insulator which, when hot, acts as a good electrical conductor, allowing current to follow the deposits and short out the plug.

Excessive gap wear on plugs of low mileage usually indicates the engine is operating at speeds or loads that are consistently greater than normal or that a plug which is too "hot" is being used. In addition, electrode wear may be the result of plug overheating, caused by combustion gases leaking past the threads and gaskets, due to insufficient compression of the spark plug gaskets, dirt under gasket, or use of old gaskets. Too lean a fuel mixture will also result in excessive electrode wear.

Spark plug life will also be affected by incorrect timing of the engine which results in excessively high operating temperature.

Broken insulators are usually the result of improper installation or carelessness. Broken upper insulators usually result from a poor fitting wrench or an outside blow. The cracked insulator may not make itself evident immediately, but will as soon as oil or moisture penetrates the fracture. The fracture is usually just below the crimped part of the shell and may not be visible.

Broken lower insulators usually result from carelessness when regapping and generally are visible. This type of a break may result from the plug operating too "Hot" such as encountered in sustained periods of high speed operation or under extremely heavy loads, especially if not installed correctly. Spark plugs with broken insulators should always be replaced.

Spark plugs, to give good performance in a particular engine, must operate within a certain

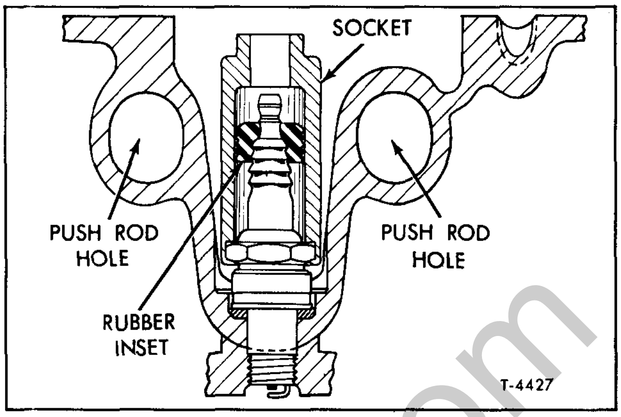


Figure 7—Wrench Socket Installed on Plug (Typical)

temperature range (neither too hot nor too cool). If the spark plug remains too "Cool," oil, soot, carbon, and lead components will deposit on the insulator, causing FOULING and MISSING. If the plug runs too "Hot," the deposits accumulated on the insulator surface during continuous slow or stop-and-go driving may become blistered, electrodes will wear rapidly, and under extreme conditions, premature ignition (preignition) of the fuel mixture result. EITHER CONDITION WILL SERIOUSLY AFFECT THE PERFORMANCE OF THE ENGINE.

Refer to "Specifications" at end of this section, as the use of spark plugs in the proper Heat Range is of vital importance to good engine performance. Frequently, the wrong type of spark plug, one with an improper Heat Range for the engine, may have been installed when replacing spark plugs originally fitted by the engine manufacturer and such misapplication may lead to poor performance.

NOTE: The Heat Range of spark plugs used on vehicles covered by this manual is designated by the two digit number on the porcelain of the plug. The higher the number the higher the Heat Range of the plug.

IMPORTANT: Spark plugs having a higher Heat Range should not be installed unless constant fouling due to light duty operation is clearly determined.

ABNORMAL OPERATION

Where abnormal operating conditions cause chronic carbon or oil fouling of the plugs, the use of a type with one or two numbers higher (a "Hotter" type) than recommended in "Specifications," will generally remedy the trouble; and by the same formula, where chronic preignition or rapid electrode wear is experienced, a type with one or two numbers lower (a "Cooler" type) will generally be found satisfactory.

SPARK PLUG REMOVAL

IMPORTANT: Before removing any spark plug, blow all dirt out of plug sockets in cylinder head with compressed air.

1. Pull wires off spark plug terminals, using caution to avoid damaging wire terminals. Remove wires by firmly grasping large end of boot.

2. Use special spark plug wrench socket No. S-9704B (manufactured by Snap-On Tool Co.) (fig. 7) and unscrew plugs from cylinder head. Ordinary wrenches may damage porcelain. If gaskets do not remain on plugs, remove from cylinder head.

INSPECTION AND CLEANING

Inspect plugs for cracked porcelain and burned points, and check point gap. Also check for loose terminals. Replace plugs which have excessively burned electrodes or cracked porcelain. Plugs should be cleaned with an abrasive type cleaner. If porcelain is badly glazed or blistered, the spark plugs should be replaced. All spark plugs must be of the same make and number of Heat Range. Use a wire feeler gauge when checking spark plug gap.

POINT GAP ADJUSTMENT

Setting spark plug gap is a precision operation and should be treated as such. Refer to "Specifications" at end of this section for proper gap dimensions. All plugs must be set to the same dimension, using a standard round feeler gauge.

CAUTION: Before adjusting gap, file center electrode flat. In adjusting the spark plug gap, never bend the center electrode which extends through the porcelain center as this may break the lower insulator. Always make adjustment by bending the ground or side electrode.

SPARK PLUG INSTALLATION

Be certain that the old gasket is removed before installation of plug and that the gasket seat is clean and smooth. Also, check that the spark plug threads and the cylinder head threads are not dirty or damaged. Dirty or damaged threads cause a faulty torque reading, resulting in incorrect installation and consequent poor spark plug life and faulty operation.

Install spark plugs in the engine with new gaskets and tighten finger-tight. Using special spark plug wrench socket (S-9704B) as shown in figure 7, and a torque wrench, tighten plugs to 23-27 foot-pounds torque.

IMPORTANT: It is important that the special socket be used in torquing plugs, as an ordinary socket will bind against cylinder head and give a false torque reading.

Spark plugs which are not tightened correctly will result in too high an operating temperature if too loose, or distortion of the spark plug body and change in gap setting or damage to the gasket if too tight.

HIGH AND LOW TENSION WIRES

High tension wires include the wires connecting the distributor cap to the spark plugs, and the wire connecting the center electrode of the distributor cap to the center terminal of the ignition coil. Low tension wires are the small wires connected to the primary terminals on the coil, and to the primary terminal at the distributor.

High tension wires have a built-in resistance of approximately 4,000 ohms per foot, except coil wire which is 8,000 ohms per foot. When replacing wires, make sure proper wires are used.

At regular intervals the wires should be inspected for damage. If insulation is cracked or swollen or oil soaked wires should be replaced.

IGNITION SYSTEM SPECIFICATIONS

ENGINE	401M 478M
DISTRIBUTOR	
Make	Delco-Remy
Model No.	1110478
Rotation (Viewed at Rotor)	CW
Point Opening (In.)	0.016
Cam Angle (degrees)	
Range	31-34 (1)
Set To	—
Centrifugal Advance (2)	
Start (degrees)	0-2
RPM	510
First Intermediate (degrees)	4-6
RPM	750
Second Intermediate (degrees)	6.5-8.5
RPM	1100
Maximum (degrees)	10-12
RPM	1750
Firing Order	1-6-5-4-3-2
Ignition Timing Point	10° BUDC
DISTRIBUTOR VACUUM CONTROL	
Make	Delco-Remy
Model No.	1973423
Inches of Mercury To Start Advance	3-5
Inches of Mercury For Maximum Advance	7-9
Maximum Advance (Engine Degrees) (3)	7.5
IGNITION COIL	
Make	Delco-Remy
Model No.	1115205
SPARK PLUGS	
Make	AC
Type	CR-43N
Size	14MM
Point Gap (In.)	0.035
Torque (Ft. Lbs.)	30-34

(1) Set with Vacuum in Retard Position.

(2) Specifications Listed are distributor degrees and Distributor RPM which are one-half Engine degrees and Engine RPM.

(3) Plus or minus one degree.

ALTERNATING CURRENT GENERATING SYSTEM

(NON-INTEGRAL TYPE)

A non-integral (generator and separate regulator) or an integral (generator with a solid state regulator built-in) type generating system is used on vehicles covered by this manual.

NOTE: The integral type generating system is covered later.

Refer to "Model Application Chart" below and "Specifications" at end of this section. This section is divided into sub-sections listed in the index following:

MODEL APPLICATION CHART

AMPERAGE TRUCK SERIES	GENERATOR	USE WITH REGULATOR
STANDARD		
42-AMP—HM/JM-80	1100842	1119507
42-AMP—TM-80	1100842	1119515
61-AMP—HV/JV/TV-70	1100849	1119507
62-AMP—HI/HN/JI/JN/MH/MI/90	1117754	1116374
75-AMP—DC/DN/FC/FN-90 (DELCO-REMY)	1117225	INTEGRAL
75-AMP—DH/DI/FH/FI-90 (DELCO-REMY)	1117231	INTEGRAL
OPTIONAL		
61-AMP—HM/JM-80	1100849	1119507
61-AMP—TM-80	1100849	1119515
62-AMP—HM/JM-80	1117754	1116374
62-AMP—TM-80	1117754	1116378
62-AMP—HI/JI/MH-90	1117756	9000590 (a)
105-AMP—DH/DI/FH/FI-90 (Leece Neville)	655988	INTEGRAL
(a) Requires 1115841 Field Relay		

GENERATING SYSTEM GENERAL DESCRIPTION (NON-INTEGRAL TYPE SYSTEM)

The basic charging system components include the battery, the self-rectifying, alternating current generator, the voltage regulator, and interconnecting wiring.

An indicator lamp (tell-tale) which indicates only whether or not the generator is charging, or an ammeter or voltmeter type charge indicator is used on all vehicles covered by this manual.

Figure 1 shows a schematic diagram of generating system on vehicles equipped with the two-unit type voltage regulator. The left view applies to vehicles equipped with the 1119515 regulator and the right view applies to vehicles equipped with the 1119507 type regulator.

Figure 2 illustrates a schematic diagram of the generating system used on vehicles equipped with the 1116374 or 1116378 transistorized type regulator.

Figure 3 illustrates a schematic diagram of the generating system used on vehicles equipped

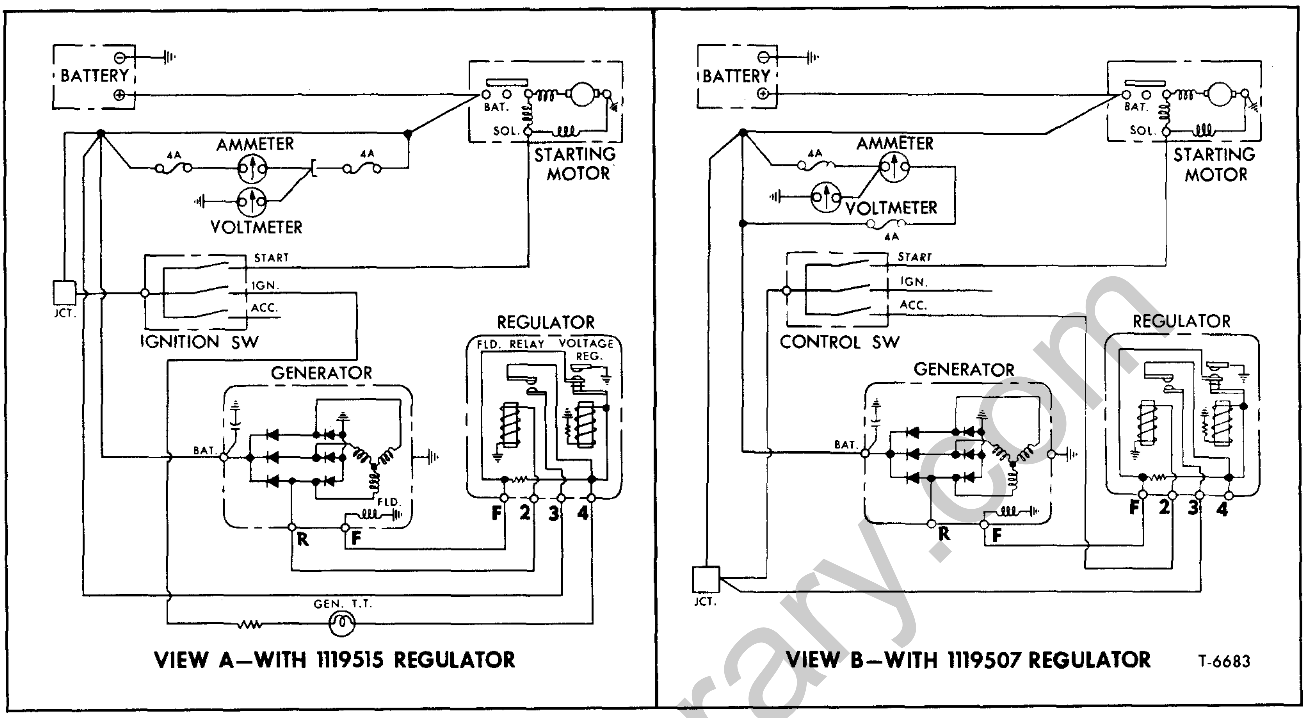


Figure 1—Schematic Diagram of A.C. Charging Circuit (with Two-Unit Type Regulator) (Typical)

with the 9000590 full transistor type regulator and separate field relay unit.

Figure 4 illustrates a schematic diagram of the generating system used on vehicles equipped with the 1119507 two-unit type regulator and the 1115827 separate field relay unit.

NOTE: Schematic diagrams of generating systems used on vehicles equipped with integral type generating systems (generator with solid state regulator built-in) are covered later in this section.

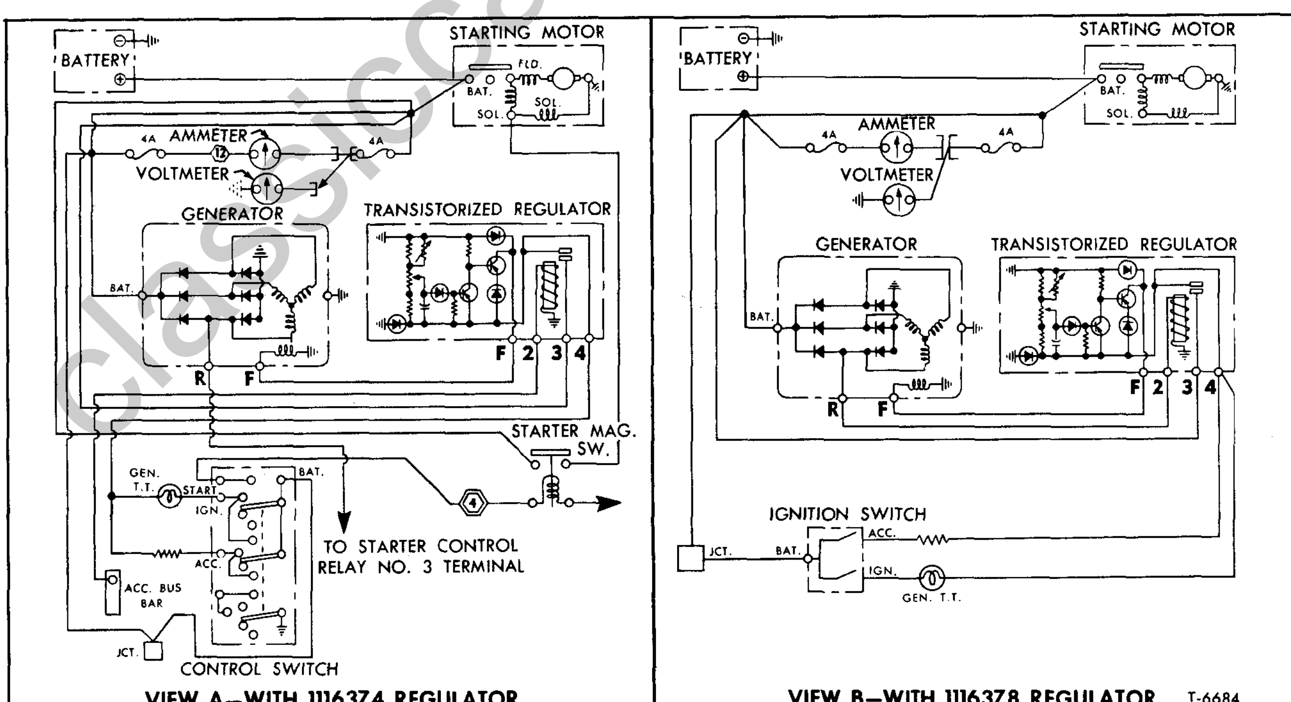


Figure 2—Schematic Diagram of A.C. Charging Circuit (with Transistorized Type Regulator) (Typical)

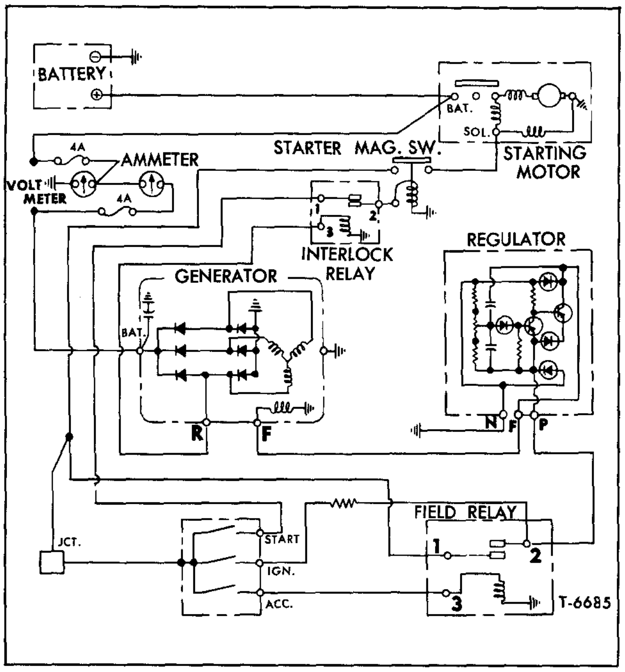


Figure 3—Schematic Diagram of A.C. Charging Circuit with Full Transistor Regulator and Separate Field Relay (Typical)

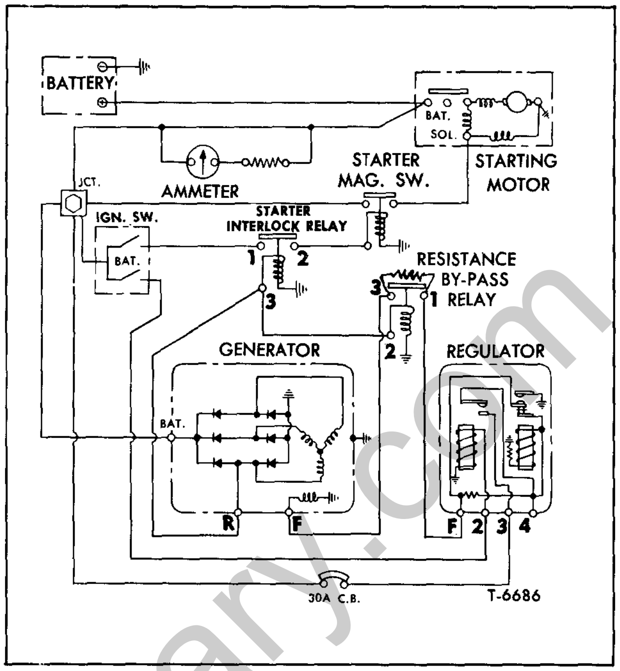


Figure 4—Schematic Diagram of A.C. Charging Circuit with 1119507 Regulator and 1115827 Field Relay (Typical)

The alternating current generators are used either as standard or optional equipment on vehicles as indicated in "Model Application Chart" at beginning of this section. All units are self-rectifying, alternating current (A.C.) type with direct current (D.C.) output.

The generators are air-cooled by a single fan attached to a drive pulley or by blades attached to both ends of the rotor assembly.

The alternating current generator consists of two major parts, a stator and rotor. The stator is composed of a large number of windings assembled on the inside of a laminated core which is attached to the generator frame. Two brushes are required to carry current through the two slip rings to the field coils wound concentric with the rotor shaft.

Although generators vary with respect to current output and type of voltage regulation, the operating principles in each system are similar.

The generator is driven from the engine and converts mechanical energy to electrical power. The alternating current produced within the generator is rectified by six diodes installed in generator end frame and heat sink assembly. Direct current is produced at output (BAT) terminal.

The regulator controls generator voltage output by varying the current flow in field windings in generator rotor assembly. No current regulating device is required in the regulator used with A.C. generator, since the generator has inherent current regulation as long as the voltage is controlled. Cut-out relay is not required with A.C. generating system as the diodes will not conduct an electric current in reverse direction; i.e., from battery to ground through the generator.

PRECAUTIONS

Observe the following precautions when performing service operations on the alternating current generating system. Failure to observe these precautions may result in serious damage to the charging system.

1. ELECTRICAL SYSTEM IS NEGATIVE GROUND. Connecting the battery or a battery charger with the positive terminal grounded will endanger generator diodes and vehicle wiring by high current flow. Burned wiring harnesses and burned "Open" diodes will result.

2. Never operate the generator on an open circuit (field terminal connected and output terminal disconnected). With no battery or electrical load in the circuit (open circuit) the generator can build up excessively high voltage. Be sure all connections in the charging circuit are secure.

3. The generator cannot be polarized. Any attempt to polarize the generator may result in serious damage to charging system components.

4. When working near the generator or regulator and before replacing electrical system components, disconnect negative lead from the battery to prevent accidental shorting at generator and regulator terminals where battery voltage is available.

NOTE: Replace voltage regulator with same type and model.

5. Do not short across or ground terminals on the generator or regulator.

6. When using a booster battery, be sure to connect negative battery terminals together and positive terminals together.

7. Disconnect battery leads while charging batteries. Do not use a fast charger as a booster for starting the engine. When attaching battery charger leads to the battery, connect charger positive lead to battery positive terminal and charger negative lead to battery negative terminal.

8. Disconnect lead from battery negative terminal before welding on vehicle since a reverse current flow from the welder may damage generator diodes as well as other electrical components.

9. Never replace the brown and white stripe special resistance wire in harness connected to the ignition or control switch unless it is of same gauge and length (approx. 60 inches long). Generating system will not function without this wire. Wire is identified on applicable diagrams as 24-BRN-WS-130. Resistance value of wire is approximately 10 ohms, 6.25 watts.

NOTE: On series HM/JM-80 wire is identified as 20-WHT. OR. & PPL. CR. TR - and is approximately 1.52 ± .07 OHMS.

IMPORTANT: Always locate and correct the cause of a malfunction to prevent reoccurrence.

ON-VEHICLE MAINTENANCE, TESTS, AND ADJUSTMENTS

GENERATING SYSTEM MAINTENANCE

At regular intervals, inspect generating system to locate and correct potential causes of trouble before generating system performance is affected.

1. Check generator drive belt tension and adjust if necessary. See procedure later under "Generator Drive Belt Tension Adjustment."
2. Check generator mounting and adjusting arm bolts and tighten as necessary.
3. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition, and that all wiring is securely clipped to prevent chafing the insulation.
4. With engine running, listen for noise and check generator for vibration. If generator is noisy or vibrates excessively, it should be removed for inspection and repair.
5. Check battery electrolyte level and replenish as necessary. Check specific gravity also.

GENERATOR DRIVE BELT

TENSION ADJUSTMENT

Because of the higher inertia and load capacity of rotor used with A.C. generators, PROPER BELT TENSION is more critical than on D.C. generators.

All generators are pivot-base mounted with the belt tension adjustment arm at the top. Use a belt tension dial gauge to check tension on each individual belt. If tension is not within 80-90 lbs. (used belts) or 100-110 lbs. (new belts), loosen the adjustment arm clamp bolt and move generator to obtain recommended tension.

On a new vehicle, or after having installed new belts, check tension twice in first 200 miles of operation. When making adjustment, examine belt(s) and replace if necessary.

A loose or broken drive belt will affect operation of generator. A drive belt that is too tight will place excessive strain on bearings.

IMPORTANT: When replacing dual drive belts, it is essential that the entire set be replaced at same time. Belts are available in matched sets only.

> **CAUTION: When adjusting belt tension, apply pressure at center of generator, never against either end frame.**

GENERATING SYSTEM TROUBLE SYMPTOMS

Abnormal operation of the generating system is usually indicated by one or more of the following symptoms:

1. Battery undercharged (low specific gravity of electrolyte).
2. Battery using an excessive amount of water, indicating an extremely high charging rate.
3. Excessive generator noise or vibration.
4. Failure of indicator lamp to illuminate when ignition or control switch is turned on (engine not running).
5. Indicator lamp continues to glow with engine running.
6. Indicator lamp fails to go out when ignition or control switch is turned off.
7. Ammeter shows a high charging rate with a fully charged battery.
8. Ammeter shows a low or no-charge with a partially discharged battery.

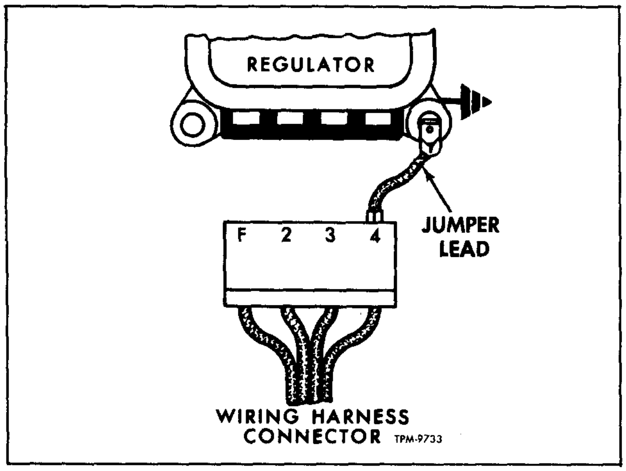


Figure 5—Jumper Lead Connections for Testing Indicator Lamp Circuit (Typical)

GENERATOR ON-VEHICLE TEST

The following is a list of the most common generator defects encountered:

1. Open or shorted generator diodes.
2. Open, shorted, or grounded stator winding.
3. Open, shorted, or grounded field winding.
4. Worn generator brushes.
5. Excessive generator noise.

Generator diodes and stator windings should be checked as explained under "Generator Output Test" later in this section. If a defect is indicated by this test, remove the generator and repair.

Generator field windings and brushes should be checked as outlined under "Charging System Trouble Analysis Chart" later in this section. If this check indicates a defect in the field winding, remove the generator and repair. Replace worn brushes as explained under "Generator Brush Replacement" later in this section.

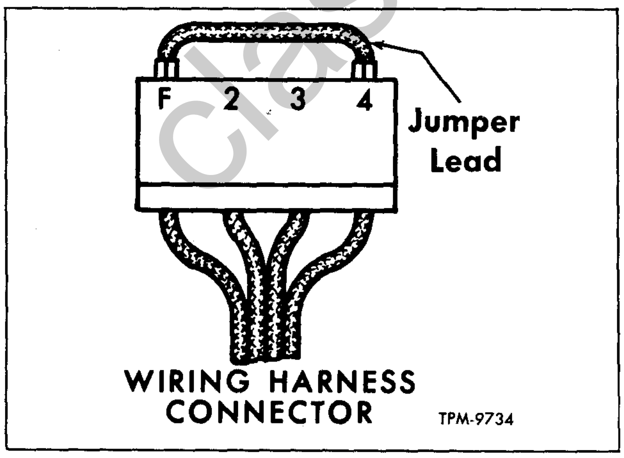


Figure 6—Checking Indicator Lamp Wiring

Excessive generator noise is usually the result of one or more of the following:

1. Brush "Squeal" caused by a hard spot on one of the brushes or rough or dirty slip rings.

To check for brush "Squeal," remove generator drive belt and spin generator drive pulley by hand. Lift brushes off slip rings and spin drive pulley again. If noise disappears, clean and inspect slip rings and replace brushes if worn.

2. Dry or rough bearings in generator end frame.

IMPORTANT: Dry or rough bearings may be the result of over-tightening generator drive belt(s). loose generator mountings, or an unbalanced generator fan or pulley. Remove generator and repair.

3. A defective diode or stator resulting in an electrical unbalance.

To check for a defective diode or stator, perform "Generator Output Test" explained later in this section. If a defect is indicated by this test, remove generator and repair.

GENERATOR CHARGE INDICATOR LAMP CIRCUIT TEST

NOTE: Refer to procedure outlined in "Charging System Trouble Analysis Chart" later in this section to determine whether something other than a generator or regulator defect is indicated before proceeding with this test which applies to vehicles equipped with a charge indicator lamp.

1. Check the indicator lamp bulb which may be burned out. Make sure socket is fully engaged.
2. Check wiring connections at junction.
3. Lift the regulator terminal latch slightly, then pull connector from regulator terminals.

CAUTION: Do not allow any leads to contact a ground or "live" wire or terminal except as directed. A heavy cloth, taped in position below regulator terminals, will assist in preventing contact.

4. Referring to figure 5, insert jumper lead (J-9782-1) into #4 terminal socket in harness connector and ground the other end to regulator base as illustrated. Momentarily (not more than 10 seconds) turn on ignition or control switch. Indicator lamp should light. If not, check for open circuit in wiring between the jumper lead and switch, switch and horn relay, and to the battery.
5. If indicator lamp comes on when #4 socket in wiring harness connector is grounded (fig. 5), connect jumper lead between wiring harness connector terminals "F" and #4 as shown in figure 6. Turn ignition or control switch on momentarily.

a. If light comes on, and open circuit exists within the regulator. Refer to regulator tests later.

b. If light does not come on, an open circuit exists between the connector and generator or in the field circuit within generator.

c. Use a long jumper lead between the #4 socket in harness connector and the "F" (field) terminal at generator. If light then comes on, the generator field circuit is good and an open circuit exists in wiring between "F" terminal on regulator and "F" terminal on generator. If light does not come on, an open circuit exists in the generator field circuit.

6. If, with all wiring connected normally, and the indicator lamp comes on when ignition or control switch is off, a defective diode is indicated.

GENERATOR OUTPUT TEST ON VEHICLE

Refer to procedures outlined in "Charging System Trouble Analysis Chart" later in this section to determine whether something other than a generator defect is indicated before proceeding.

QUICK TEST FOR OUTPUT

1. Connect voltmeter "POS" lead to generator output terminal and "NEG" voltmeter lead to ground on chassis.
2. Start engine and turn heater motor to medium speed position.
3. Increase engine speed until voltmeter reading does not increase and record reading.

IMPORTANT: DO NOT EXCEED 2000 RPM.

4. Disconnect ground (NEG) cable from the battery.
5. If voltmeter reading is lower than in Step 3 above, a defective generator is indicated. Remove generator and repair.

GENERATOR OUTPUT TEST
(EXCEPT 9000590 REGULATOR)

1. Disconnect positive cable from battery.
2. Remove wire from "BAT" terminal on generator, and connect an ammeter between wire and "BAT" terminal on generator (fig. 7).
3. Install a voltmeter between the generator "BAT" terminal and "GRD" terminal.
4. Pull latch on regulator upward to disengage from connector, then pull wiring harness connector from regulator. Connect a jumper lead between "F" terminal socket and #3 socket as shown in figure 8.

IMPORTANT: With wiring connected as shown in figure 7, the voltage regulator is taken out of the circuit, and causes field to be energized by full battery voltage. Generator output voltage must be controlled by loading the battery with a carbon pile or turning on vehicle accessories. Do not permit voltage to exceed setting specified for regulator as listed in "Specifications."

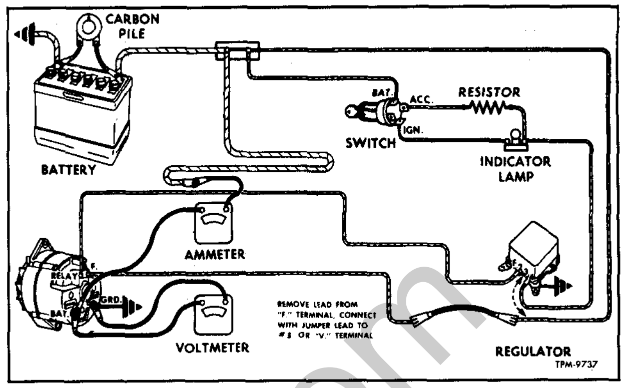


Figure 7—Connections for Testing Generator Output (Except 9000590 Regulator) (Typical)

5. Connect a tachometer to engine, then connect positive cable to battery and start engine. Adjust engine speed and carbon pile (if used) or with vehicle accessories to provide rated voltage. Ratings for each generator are given in "Specifications" at end of this section. If generator does not produce current within its rated capacity, it can be considered defective and in need of repair.

NOTE: Procedure for replacing generator are given later.

6. Remove instruments and jumper lead and connect wiring harness connector to regulator.
7. If no defects were discovered by the foregoing tests, yet the battery remains undercharged, adjust voltage regulator setting as explained under applicable regulator later in this section.

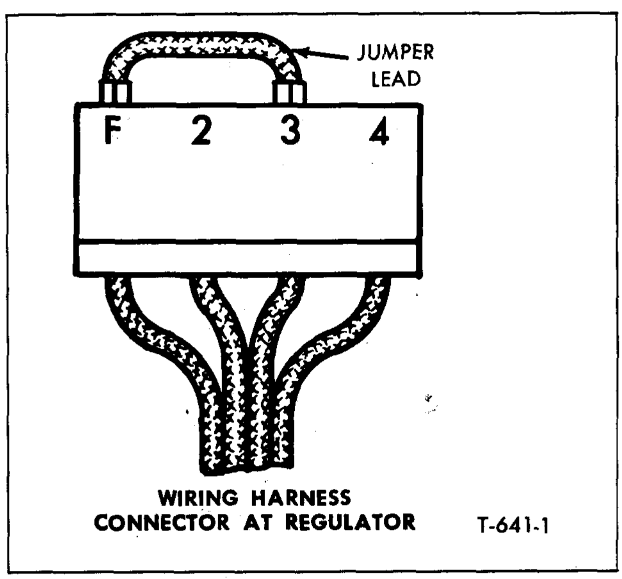


Figure 8—Generator Output Test (Jumper Lead Connections at Regulator) (Except 9000590 Regulator) (Typical)

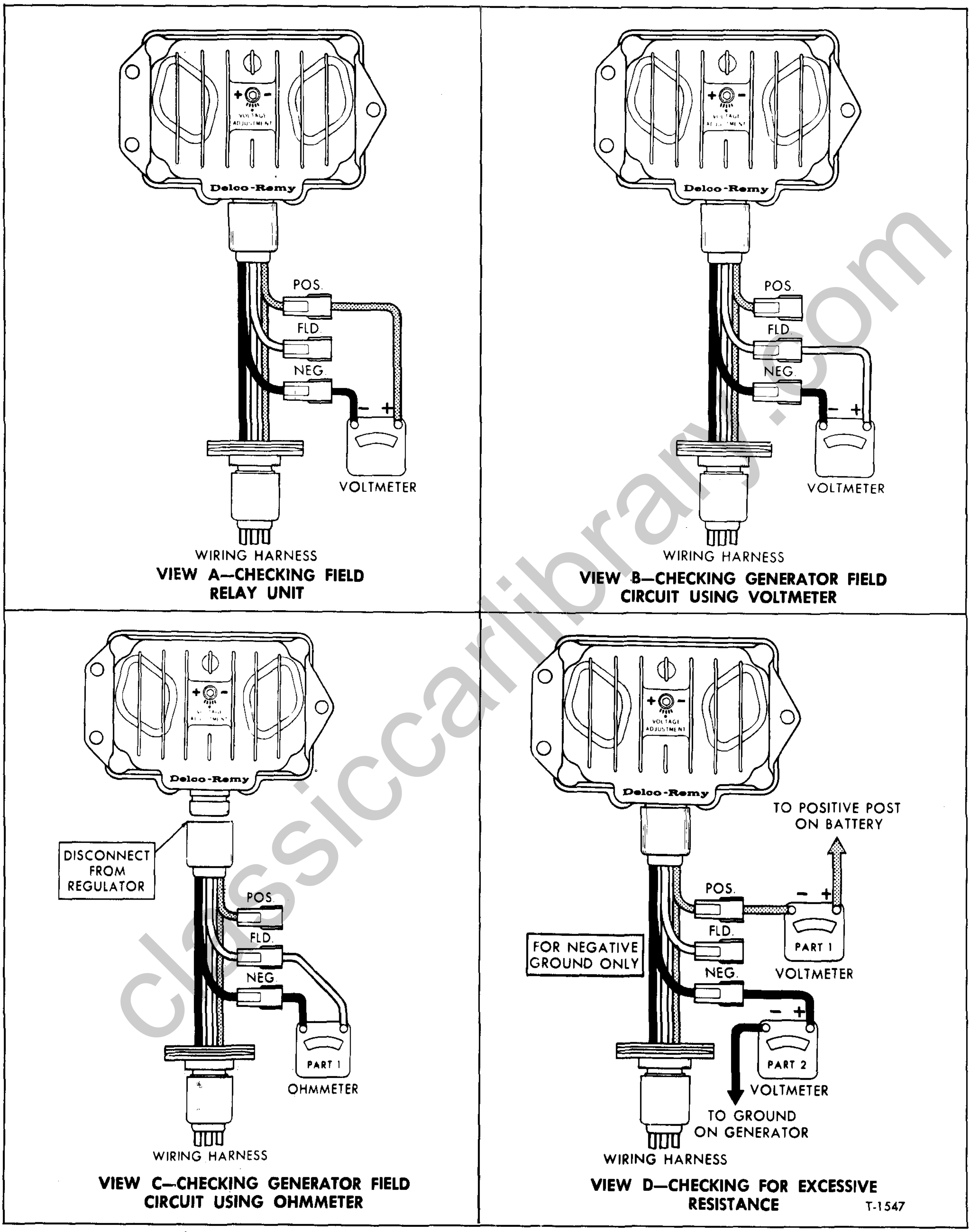


Figure 9—Using Adapter (J-21600) to Check Generator Output (Full Transistor Regulator)

GENERATOR OUTPUT TEST
(WITH 9000590 REGULATOR)

1. Connect a voltmeter to the adapter as shown in View A, figure 9.

2. Turn on the ignition or control switch.

3. Operate generator at specified speed and check for rated output as given in "Specifications" at end of this section. Load the battery with a carbon pile or vehicle accessories (if needed) to obtain rated output. If generator does not produce rated output, repair or replace the generator.

GENERATOR FIELD CIRCUIT CHECK (WITH 9000590 TYPE REGULATOR)

1. Connect a voltmeter to the test adapter as shown in View B, figure 9.

2. Turn the ignition or control switch on.

3. If the voltmeter indicates zero volts, check the generator field as follows:

a. Turn the ignition or control switch off and disconnect the battery ground strap.

b. Disconnect the adapter from the regulator.

c. Connect an ohmmeter to the adapter as shown in View C, figure 9.

d. If the ohmmeter indicates high, there is an open, or excessive resistance in the field winding, or in wiring between regulator positive terminal and generator F1 terminal.

e. If the ohmmeter indicates low, the winding is shorted or grounded.

NOTE: Since the reading is taken through the adapter, leads, brushes and slip rings, the ohmmeter reading on a good field winding will be slightly higher than the specified value. This is because the specified value is for an ohmmeter reading directly across the slip rings.

f. Disconnect ohmmeter and reconnect the battery ground strap.

4. If the voltmeter indicates battery voltage, the regulator is shorted and must be replaced, or the generator field winding is open or grounded. Check as follows:

a. To check the generator field, turn the ignition or control switch off and disconnect battery ground strap.

b. Disconnect test adapter from the regulator.

c. Connect an ohmmeter to the adapter as shown in View C, figure 9.

d. If the ohmmeter indicates high, there is an open, or excessive resistance in the field winding, or in the wiring between regulator positive terminal and generator F1 terminal.

e. If the ohmmeter indicates low, the winding is shorted or grounded.

f. Disconnect ohmmeter and reconnect the battery ground strap.

g. To check the regulator, connect a voltmeter as shown in View A, figure 9, and operate the engine at moderate speed. If the voltage is uncontrolled and increases with speed to values above the specified setting range, replace or repair the regulator.

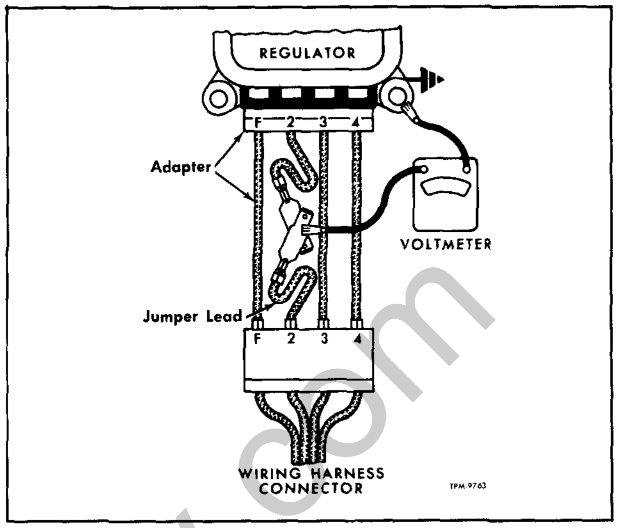


Figure 10—Testing Regulator Field Relay (Two-Unit Type Regulator)

REGULATOR UNIT FIELD RELAY TEST ON VEHICLE

If generator charge indicator shows no charge, the regulator field relay or possibly the generator is at fault. To determine which is at fault, proceed as follows:

1. Make connections at regulator and connector terminals as shown in figure 10.

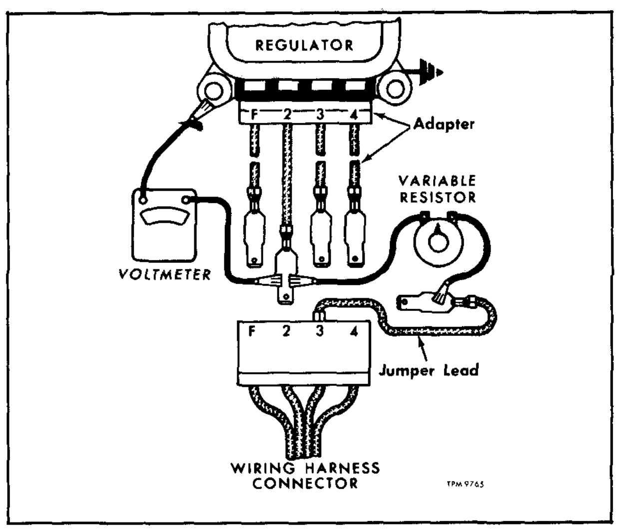


Figure 11—Testing Field Relay Closing Voltage Two-Unit Type Regulator (Typical)

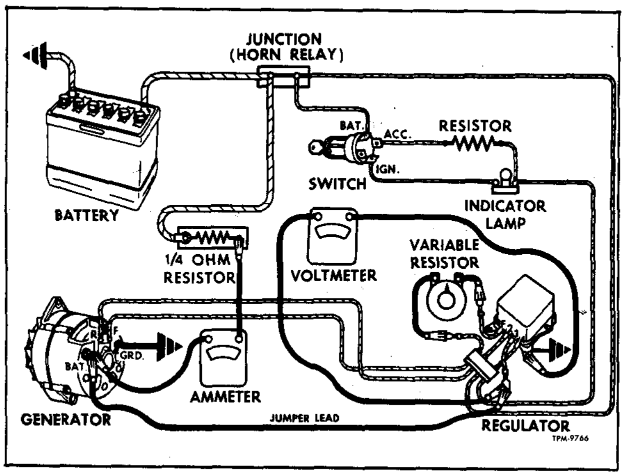


Figure 12—Connections for Testing Regulator Voltage Setting (Two-Unit Type Regulator)

2. Start engine and operate at fast idle and observe voltmeter reading. If reading is 5 volts or over and indicator shows no charge, the field relay is defective and must be checked.

3. If voltmeter reading is below 5 volts on the 1119515 regulator or 8 volts on the 1119507 regulator, trouble is in the generator.

4. The field relay closing voltage can be checked on the vehicle as follows:

NOTE: Refer to figure 11 for test connections.

a. Connect a 100-150 ohm variable resistor and a voltmeter to the test adapter as shown in figure 11.

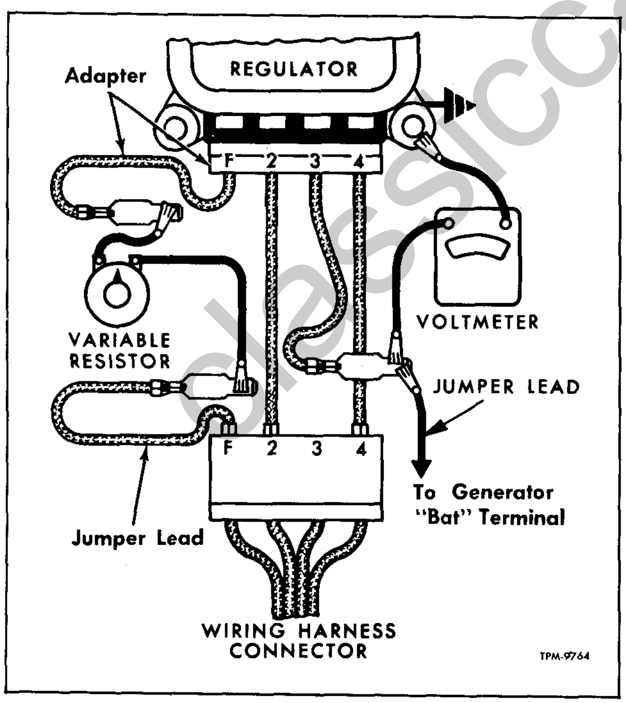


Figure 13—Testing Voltage Setting (Two-Unit Regulator)

NOTE: If a 0-50 ohm variable resistor (J-21260) is used, it will be necessary to add a 15 and a 115 ohm resistor in same series to provide the required resistance.

b. Turn resistor to open or "full resistance" position. Leave ignition or control switch off.

c. Slowly decrease resistance and note the closing voltage. Voltage should be 1.5 to 3.2 volts on the 1119515 regulator or 3.8 to 7.2 volts on the 1119507 regulator. If necessary, adjust voltage by bending the armature support heel iron.

REGULATOR VOLTAGE TEST ON VEHICLE

The voltage at which the regulator operates, varies with changes in regulator ambient temperature which is the temperature of air at a distance of ¼-inch from the regulator.

NOTE: The 9000590 type regulator is not noticably affected by changes in temperature.

GENERATING SYSTEM WITH
TWO-UNIT TYPE REGULATOR

NOTE: On some generating systems, No. 2 terminal on regulator is energized by system voltage rather than by voltage at generator "R" terminal.

1. Refer to figure 12 which shows all test equipment connected into system. Figure 13 shows use of special adapter and jumper lead at regulator.

2. Connect an ammeter and a ¼-ohm resistor with a rating of 25 watts or more in series in the circuit at the "BAT" terminal on the generator (fig. 12). In the event the battery is discharged, the ¼-ohm resistor will limit the generator output to 10 amperes or less which is required, when checking and adjusting the voltage setting.

3. Install special adapter as shown in figure 12. Use a 25 ohm 25 watt variable resistor in series with the generator field windings at the regulator "F" terminal, and connect a jumper lead from the #3 adapter lead to the generator "BAT" terminal as shown. Connect a voltmeter from the #3 adapter lead to ground as shown. Turn the resistor to the closed or "no resistance" position.

4. Secure a thermometer close to regulator to establish operating temperature. With all accessories and lights off, start and operate engine for 15 minutes at 1500 engine rpm.

5. After warm-up, cycle generator as follows:

a. Turn variable resistor to "OFF" or "FULL RESISTANCE" position.

b. Disconnect lead at #4 terminal of harness connector momentarily, then reconnect lead.

c. Return variable resistor to the closed or "no resistance" position.

d. Bring engine speed up to approximately

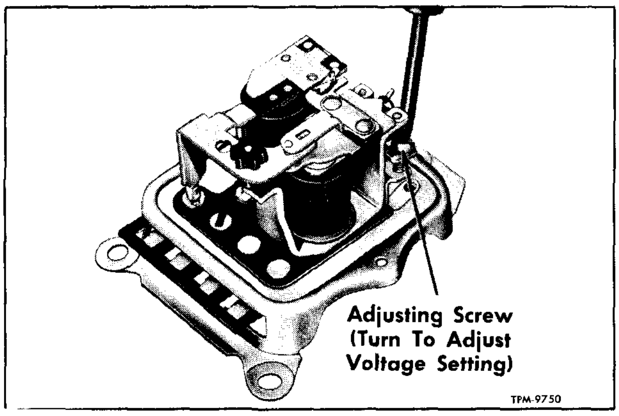


Figure 14—Adjusting Voltage Setting (Two-Unit Regulator)

2500 rpm and note the voltage setting. Refer to applicable "Temperature Voltage Chart" in "Specifications" at end of this section.

NOTE: The regulator unit should be operating on the upper or shorting contacts. If it will not operate on the upper contacts, the battery is in extreme state of discharge, and must be at least partially recharged before proceeding with test.

6. To prevent accidental grounding and consequent damage to internal regulator parts when removing or installing regulator cover, perform the following steps in order listed:

a. Disconnect #4 lead at harness connector.

b. Disconnect jumper lead at generator "BAT" terminal.

c. Remove regulator cover.

d. Reconnect jumper lead to generator "BAT" terminal.

e. Connect #4 lead to harness connector.

7. To adjust the voltage setting, turn adjusting screw as shown in figure 14.

IMPORTANT: Always turn screw clockwise to make final setting to insure spring-holder being against head of adjusting screw. If necessary, pry holder up against screw head before turning screw clockwise.

8. After making the setting, cycle the generator again as directed previously in Step 5.

9. Operate engine at approximately 2500 rpm and note voltage setting. Readjust if necessary.

10. Check the voltage setting while operating on the lower set of contacts as follows:

Slowly increase the resistance of the variable resistor with the engine operating at 2500 rpm until the regulator begins to operate on lower set of contacts. Then, note the change in voltage reading. The upper set voltage should be 0.1 to 0.4 volt higher than on lower contacts.

The most desirable method for determining that the regulator is operating on the lower set of contacts when the cover is installed is to use earphones (if available) connected across the regulator

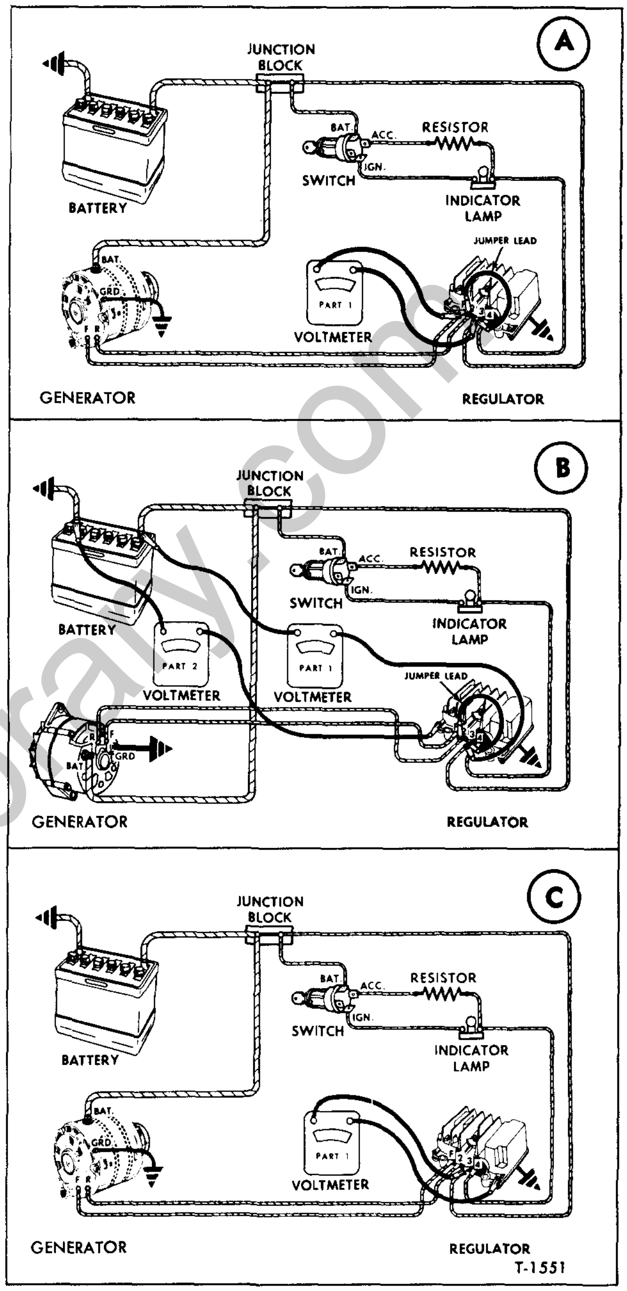


Figure 15—Connections for Testing 1116374 or 1116378 Regulator Voltage Setting (Typical)

"F" terminal to ground. As the variable resistor is turned, and operation changes from the upper set of contacts to the lower set, the earphones sound will fade away and stop completely and then return when the lower set of contacts begin to operate. The alternate method is visual observation, but this is less desirable because the cover must be removed which affects temperature stabilization.

NOTE: If turning the variable resistor does not cause the regulator to operate on the lower set of contacts, return the variable resistor to the "no resistance" position, turn the carbon pile to slightly load the battery, and then adjust the variable resistor to cause the regulator to operate on the lower set of contacts. Usually, turning on the vehicle head lights can substitute for the carbon pile.

The difference in voltage between the operation of the upper set of contacts and the lower set is increased by slightly increasing the air gap between the armature and center of core and decreased by slightly decreasing the air gap using nylon adjusting nut. This adjustment can be made while the regulator is operating. If necessary to make this air gap adjustment, recheck the voltage setting of both sets of contacts.

11. Always make final voltage test after the regulator cover is installed.

IMPORTANT: Observe special procedure in Step 6 previously when installing and removing regulator cover.

12. The regulator can be removed and checked as directed later under applicable "Voltage Regulator."

SYSTEM WITH 1116374 OR 1116378 REGULATOR

NOTE: On vehicles equipped with the No. 1116374 regulator, voltage is controlled by battery voltage rather than by "R" terminal.

1. Make connections as shown in View A, figure 15.

NOTE: Voltmeter is connected between regulator "F" terminal and #2 terminal and jumper lead is connected between regulator #2 terminal and #3 terminal.

CAUTION: DO NOT leave jumper lead connected longer than five minutes.

2. If voltage in Step 1 is less than 0.9 volt or greater than 2.0 volts, replace the regulator.

3. If voltage in Step 1 was between 0.9 and 2.0 volts, proceed as follows:

a. Make connections as shown in View B, Part 1, figure 15. and record the voltage drop.

NOTE: Voltage is connected between battery positive terminal and regulator #3 terminal, and jumper lead is connected between regulator #2 and #3 terminals.

b. Make connections as shown in View B, Part 2, figure 15, and record the voltage drop.

c. Add voltage in Step a. to voltage in Step b. above. If total voltage (a. + b.) is above .25 volt, check system wiring for high resistance.

d. If total voltage in Step c. is below .25 volt, make connections as shown in View C, figure 15; then with switch on, operate engine at 1,275 rpm for 15 minutes. Leave cover on regulator. Place a thermometer ¼-inch from regulator cover and compare voltage with "Specifications" given in "Temperature Voltage Chart" at end of this section.

4. If voltage is not within specified range, replace the regulator.

5. If voltage is within specified range, remove plug and turn the slotted adjuster inside regulator (fig. 16). Use a thin, flat-bladed instrument.

6. To raise the voltage setting, turn slotted adjusting plug one notch (clockwise), then check for an improved battery condition after a service period of reasonable length.

NOTE: After two notches in each direction there is a positive stop.

7. To lower the voltage setting, turn slotted adjusting plug one notch (counterclockwise), then check for an improved battery condition after a service period of reasonable length.

8. If regulator cannot be adjusted to a value within the specified range, replace the regulator.

NOTE: If repeated regulator failures are experienced on the vehicle, but no defects are found, a shorted, grounded, or open generator field winding, or grounded leads of an intermittent nature should be suspected.

GENERATING SYSTEM WITH 9000590 REGULATOR

1. Connect a voltmeter to the adapter as shown in View A, figure 9.

2. Turn all accessories off.

3. Operate generator at approximately 3,000 rpm (approx. 1200 engine rpm).

4. The generator output should be at least 10 amperes below the rated generator output for this check.

5. To adjust voltage setting, remove plug and turn slotted adjusting button inside regulator (fig. 16). Use a thin flat-bladed instrument.

6. For an undercharged battery, raise voltage setting by turning one notch (clockwise) and then check for an improved battery condition after a service period of reasonable length.

NOTE: After two notches in each direction, there is a positive stop.

7. For an overcharged battery, lower voltage setting by turning one notch (counterclockwise) and then check for an improved battery condition

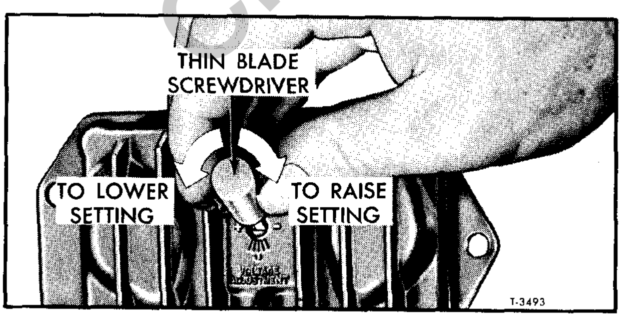


Figure 16—Adjusting Voltage Setting (Typical)

after a service period of reasonable length.

8. If the regulator cannot be adjusted to a value within the specified range, replace or repair the regulator.

NOTE: If repeated regulator failures are experienced on the vehicle, but no defects are found, a shorted, grounded, or open generator field winding, or grounded leads, of an intermittent nature should be suspected.

TAILORING THE VOLTAGE SETTING

The proper setting is obtained when the battery remains fully charged with a minimum use of water.

If any circuit defects are found, yet the battery remains undercharged, raise the setting by 0.3 volts, then check the battery over a period of time to see if improvements were achieved; reset regulator if necessary. If the system is overcharging, lower the setting by 0.3 volts, then check battery over a period of time.

GENERATOR REPLACEMENT

Due to variations in design and equipment on vehicles using A.C. generators, the replacement procedures will vary accordingly. The removal and installation instructions given following are intended only as a guide. Additional operations will be required on some vehicles to remove other equipment to permit access to generator, belts, and/or brackets.

GENERATOR REMOVAL

1. Disconnect negative battery cable from battery.

> **CAUTION: It is important that battery negative terminal be disconnected, since generator will be damaged if wiring or terminals are accidentally shorted or grounded while being disconnected.**

2. On 42-, 61-, and 62-amp generators, depress lock on connector and pull connector out of socket on generator. Pull rubber boot off "BAT" terminal and remove terminal nut. Disconnect wire from "GRD" terminal and remove wiring clip.

On the 130-amp generator, remove nuts and washers from harness leads at generator terminals. Remove harness clip from generator, then pull leads from terminals.

3. Loosen adjusting arm pivot bolt and generator to mounting bracket bolts. Move generator to loosen drive belt(s) and remove from generator pulley.

4. Remove adjusting arm pivot bolt and generator to mounting bracket bolts; then remove generator.

GENERATOR INSTALLATION

IMPORTANT: Be sure negative battery cable is disconnected from battery. Failure to disconnect the negative battery cable may result in damage to generator.

1. Attach generator to mounting bracket and install adjusting arm pivot bolt.

2. Place drive belt(s) over generator drive pulley and adjust belt tension as explained under "Drive Belt Tension Adjustment" previously. Tighten flange type lock nuts and mounting bolts to torque recommended in "Specifications" at end of this section.

3. On 42-, 61-, or 62-amp generators, push the wiring harness connector into socket, making sure lock on connector engages end frame. Place harness clip on ground terminal marked "GRD" and connect ground wire to terminal.

On the 130-amp generator, connect harness leads to respective generator terminals, then install attaching nuts and washers. Install harness clip.

4. Attach red wire to "BAT" terminal on generator and fit boot over terminal.

5. Perform "Generator Output Test" described previously to determine if generator is operating properly and that regulator is correctly adjusted.

GENERATOR BRUSH REPLACEMENT

NOTE: Brush replacement on 42-, 61-, and 130-amp generator models requires partial disassembly of the generator and is considered a part of the unit overhaul procedure.

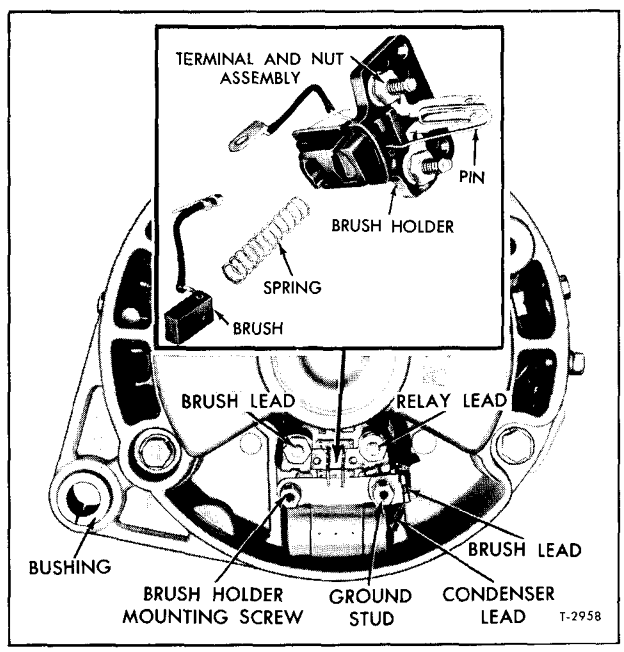


Figure 17—Generator Brush Replacement (Model 1117754) (Typical)

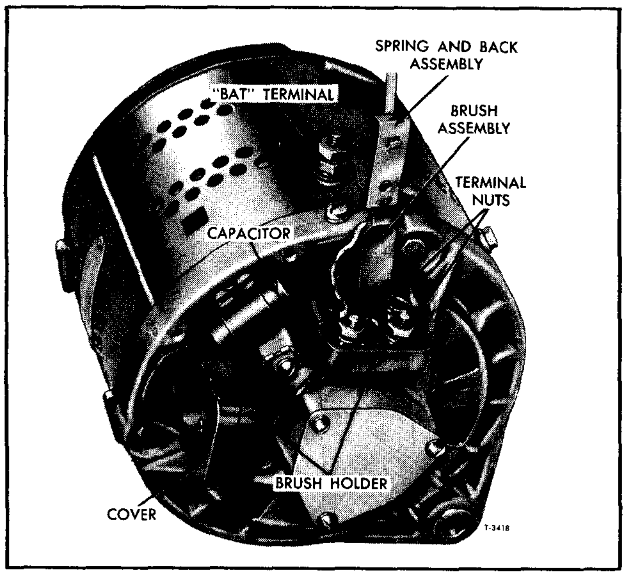


Figure 18—Generator Brush Replacement (Model 1117756) (Typical)

GENERATOR BRUSH REPLACEMENT
(MODEL 1117754) (Fig. 17)

1. Remove screws from brush holder cover and remove cover.
2. Remove nut retaining indicator light wire to connector and disconnect lead from post.
3. Remove two screws which attach condenser and brush holder to rear end frame.

NOTE: Condenser lead is connected inside the generator. Leave condenser with generator.

4. Remove brush holder, brushes, and brush springs from generator end frame.
5. Position brush springs and brushes in brush holder and insert a pin through hole in brush holder and brushes to retain in position.
6. Position brush holder and brushes in end frame, then secure brush and condenser leads to terminals as shown in figure 17.
7. Install brush holder mounting screws and tighten firmly.
8. Remove pin from brush holder and check to be sure all leads are properly connected. Install cover over brush holder.

GENERATOR BRUSH REPLACEMENT
(MODEL 1117756) (Fig. 18)

1. Remove cover from brush holder.
2. Remove nuts and washers from brush terminals.
3. Press down and in on brush spring and back assembly to disengage from brush holder. Lift both brush assemblies out of cavities in brush holder.
4. Position both brush assemblies in cavities in brush holder as shown in figure 18.
5. Attach brush leads to terminals and secure with nuts and washers. Tighten nuts firmly.
6. Position a brush spring and back assembly over each brush, then press down on spring and back assembly to engage lock tangs in brush holder.
7. Position cover over brush holder and secure with screw.

TWO-UNIT TYPE REGULATOR (MODEL 1119507 OR 1119515)

GENERAL

The two-unit type voltage regulator is used on all models equipped with the 42-, or 61-amp generating system. Operation of regulator and other affiliated generating system units is explained previously under "Generating System General Description."

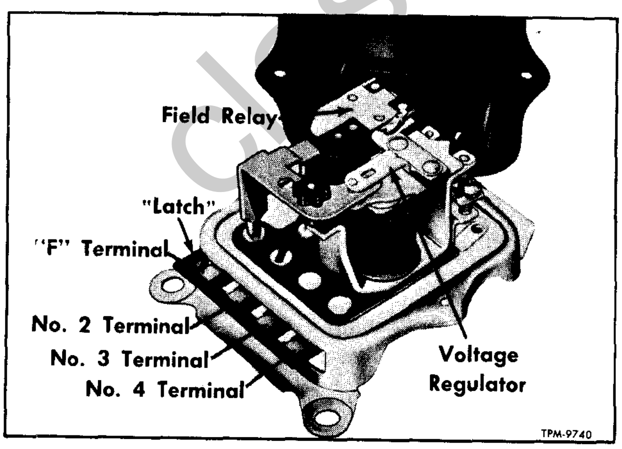


Figure 19—Regulator with Cover Removed

REGULATOR REPLACEMENT

NOTE: On conventional cab models the voltage regulator is mounted on engine side of dash panel. On steel and aluminum tilt cab models the regulator is mounted on the radiator front support or on the transmission control island front support. On "R" models, the regulator is mounted on the rear electrical equipment control panel.

REMOVAL

1. Disconnect the negative cable from battery.
2. Carefully lift up on regulator wiring harness connector with one hand with the other, pull harness connector from regulator.
3. Remove regulator mounting screws, then remove regulator assembly.

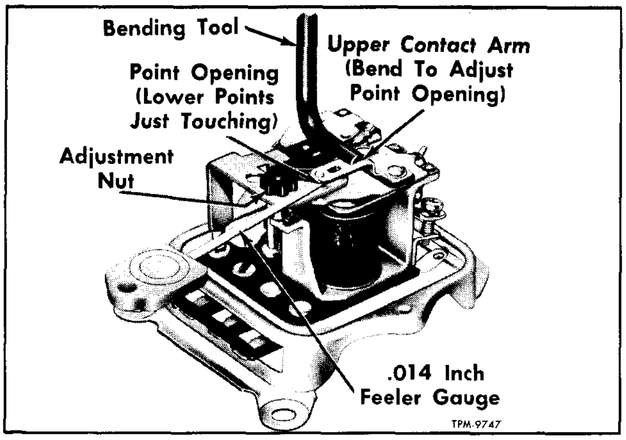


Figure 20—Adjusting Point Opening

INSTALLATION

IMPORTANT: Make sure negative battery cable is disconnected from battery.

1. Place regulator-to-generator ground wire (if used) on regulator mounting and install regulator attaching screws.

2. Lift up on regulator terminal latch and insert wiring harness connector over regulator terminals.

IMPORTANT: Make sure connector is fully engaged over terminals and locked in position. Check by attempting to pull connector apart.

3. Connect battery cable to battery terminal.

GENERAL INSPECTION

With the regulator assembly on work bench, remove the cover (fig. 19) and inspect various components, connections, and contact points for signs of damage.

VOLTAGE REGULATOR UNIT CHECK

CLEANING CONTACT POINTS

If the contact points are dirty or oxidized, they must be cleaned before any adjustments are made since the cleaning may change the mechanical settings. The upper contacts may develop slight cavities. These surfaces should be cleaned to bare metal with #400 silicone carbide paper or equivalent folded over, then pulled back and forth between contacts.

It is not necessary to remove the cavities entirely. The lower contacts are of softer material; use a piece of cloth with solvent to remove any discoloration.

IMPORTANT: DO NOT USE AN ABRASIVE ON THESE POINTS.

After contacts have been cleaned they should be washed with a solvent (non-toxic type) to remove any foreign material.

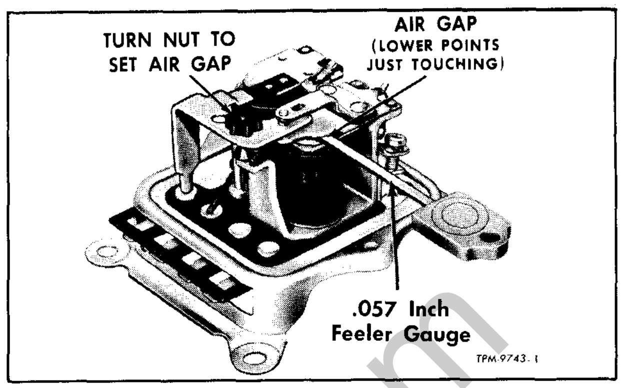


Figure 21—Adjusting Air Gap

CHECKING AND ADJUSTING CONTACT POINT OPENING

With the lower contacts touching, measure the point opening between the upper contacts as shown in figure 20. Point opening should measure 0.014". Adjust by bending the upper contact arm as shown.

CHECKING AND ADJUSTING AIR GAP

Measure air gap with a 0.057-inch feeler gauge between the armature and the core when lower contacts are just touching as shown in figure 21. To adjust the air gap, turn the adjustment nut located on the contact support.

NOTE: Only an approximate air gap setting should be made by the feeler gauge method above. The final setting must be whatever is required to obtain the specified difference in voltage between the upper and lower contacts. Instructions for making final setting are explained previously. See "Regulator Voltage Test (On Vehicle)."

FIELD RELAY UNIT CHECK

Four checks are required on the field relay:

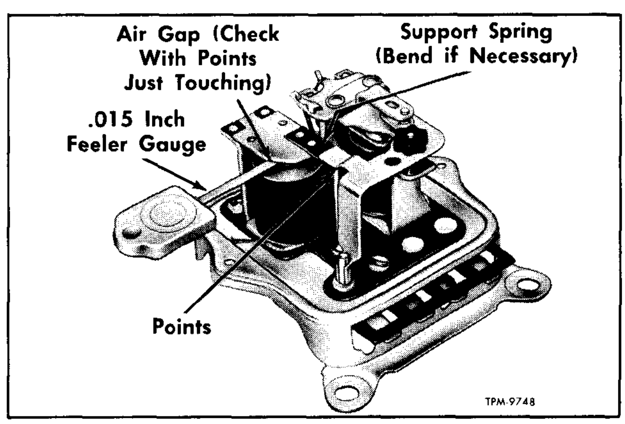


Figure 22—Adjusting Field Relay Air Gap

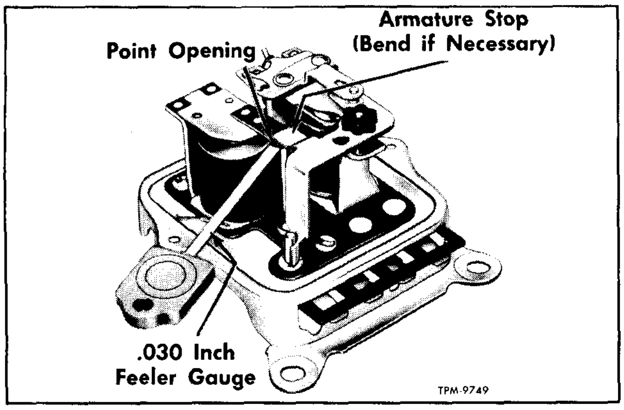


Figure 23—Adjusting Field Relay Contact Points

(1) Checking and cleaning contact points, (2) Checking and adjusting air gap, (3) Checking and adjusting contact point gap, (4) Checking and adjusting the closing voltage.

NOTE: Check closing voltage as explained previously under "Regulator Unit Field Relay Test on Vehicle."

CHECKING AND CLEANING CONTACT POINTS

If points appear to be pitted or burned, clean points using a thin cut file.

IMPORTANT: Remove only enough material to clean points. NEVER use emery cloth or sandpaper to clean points.

CHECKING AND ADJUSTING AIR GAP

Referring to figure 22, insert a 0.030 inch gauge between the armature and core and exert just enough pressure on the armature to allow it to touch the gauge. The contact set should just close at this time. Adjust by bending the flat contact support spring.

CHECKING AND ADJUSTING CONTACT POINT GAP

Referring to figure 23, insert an 0.030 inch feeler gauge between the contact points with the armature in its normal rest position.

The point opening can be adjusted by bending the relay heel iron.

TRANSISTORIZED TYPE REGULATOR (MODEL 1116374 OR 1116378)

GENERAL

The transistorized regulator (fig. 24) is used on models equipped with the 62- or 130-amp generator as shown in "Model Application Chart" previously.

The regulator is composed of transistors, diodes, capacitors and resistors which form a completely static electrical unit containing no moving parts.

The function of regulator is to limit voltage to a given value. The voltage at which generator is limited is determined by the regulator adjustment which, when adjusted, remains practically unchanged. Refer to "Regulator Adjustment" later in section.

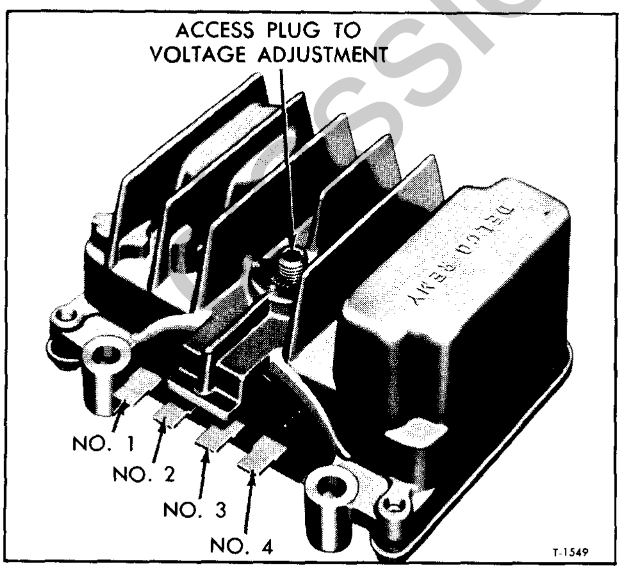


Figure 24—Transistorized Type Regulator (Typical)

CAUTION

The field wire terminal must not be grounded or flashed when regulator is connected into circuit as instant damage to transistors will result.

OPERATING PRINCIPLES

In the circuit illustrated in figure 2 in "Generating System General Description" section, when ignition switch is closed and engine is not running, the ammeter will show a discharged condition or the indicator lamp will "light," to indicate the generator is not charging. The current flow can be traced from the battery to the "BAT" terminal on the ignition switch, through the indicator lamp and resistor, then to No. 2 or 4 terminal on the regulator. From here it continues to flow through transistor TR-1 to "F" terminal on the regulator and on through the generator field winding to ground, completing the circuit back to the battery.

When the engine is started and generator begins to operate, A.C. voltages are induced in the generator stator windings. These voltages are changed or rectified to D.C. voltage which appears at the output, or "BAT" terminal on the generator. The generator then supplies current to charge the battery and operate vehicle accessories.

On 62-amp systems voltage from the "R" terminal on the generator is impressed through the regulator #2 terminal and through the field relay winding, causing the relay contacts to close. This connects the regulator #4 terminal directly to battery through the field relay contacts, causing the indicator lamp to go "OUT." Generator field current then flows from the generator or battery to the regulator #3 terminal, then through the field relay contacts and transistor TR-1 to the generator field winding.

As generator speed increases, the voltage reaches the pre-set value and components in the regulator cause transistor TR-1 to alternately "turn-off" and "turn-on" the generator field voltage. The regulator thus operates to limit the generator output voltage to the pre-set value.

NOTE: An ammeter type charge indicator is used as standard equipment on conventional cab models and is available as optional equipment on steel tilt cab models. A voltmeter type charge indicator is available as optional equipment on all models.

ANALYZING CHARGING SYSTEM TROUBLES

NOTE: Procedures for analyzing or checking charging system trouble are explained previously.

Adapter (J-9782-3) may be used at the regulator to facilitate checking circuits.

If trouble is located in the generator during the test procedures, refer to the applicable generator section for corrective procedures.

When analyzing the system, make sure all connections between the battery, junction block, and generator are clean and tight, then remove the wiring harness connector from the regulator and connect the adapter between the wiring harness connector and the regulator.

REGULATOR ADJUSTMENT

NOTE: Refer to "Charging System Trouble Analysis Chart" later in this section for procedures for analyzing and checking charging system malfunctions.

1. Connect (POS) voltmeter lead to battery (POS) terminal on regulator and (NEG) voltmeter lead to ground on regulator.
2. Adjust engine speed to approximately 1500 rpm, then turn heater to medium speed and turn all other electrical load "OFF." Disconnect (NEG) cable from battery.
3. Place a thermometer (J-8529) approximately ¼-inch from regulator cover and operate for approximately 15 minutes.
4. Compare voltmeter reading with those given under applicable regulator in "Specifications" at end of this section.
5. If voltmeter is not within limits listed in "Specifications," remove plug from regulator cover and insert a thin-bladed screwdriver into adjustment screw.

NOTE: After two notches in either direction there is a positive stop.

IMPORTANT: Do not force adjusting screw beyond normal stop. Forcing the screw beyond the normal stop will destroy the regulator.

6. For an undercharged battery, raise voltage setting by turning adjusting screw one notch (clockwise) then check for an improved battery condition after a service period of reasonable length.
7. For an overcharged battery, lower voltage by turning adjusting screw one notch (counterclockwise), then check for an improved battery condition after a service period of reasonable length.
8. If the regulator cannot be adjusted to within limits listed in "Specifications," at end of this section, repair or replace the regulator.

REGULATOR REPLACEMENT AND REPAIR

REGULATOR REMOVAL

1. Disconnect the negative battery cable from battery.
2. Carefully lift up on regulator wiring harness connector with one hand and with the other, pull harness connector from regulator.
3. Remove regulator mounting screws, then remove regulator assembly.

REGULATOR REPAIR

With the regulator on work bench remove the cover and inspect various components, connections, and field relay contact points for signs of damage.

If field relay contact points are dirty or oxidized, they should be cleaned. The contact surfaces may oxidize and develop a slight cavity. These surfaces should be cleaned to bare metal using a riffler file.

IMPORTANT: DO NOT file excessively.

If the voltage regulator cannot be adjusted to within specifications listed at end of this section, replace the regulator assembly.

REGULATOR INSTALLATION

IMPORTANT: Make sure one battery cable is disconnected from battery.

1. Place regulator-to-generator ground wire on regulator mounting and install regulator attaching screws.

2. Lift up on regulator terminal latch and insert wiring harness connector over terminals.

IMPORTANT: Make sure connector is fully engaged over terminals and locked in position. Check by attempting to pull connector apart.

3. Connect battery cable to battery terminal.

FULL TRANSISTOR TYPE REGULATOR (MODEL 9000590)

GENERAL

The full transistor regulator illustrated in figure 25, is used on vehicles equipped with the No. 1117756 (62-amp) generator and a separate field relay unit.

The separate field relay is used to disconnect the regulator feed (POS) terminal from the battery circuit when the ignition or control switch is in the "OFF" position.

NOTE: The field relay units are non-adjustable or repairable. If the relay becomes inoperative replace with a unit of the same type.

CAUTION

The field wire terminal must not be grounded or flashed when the regulator is connected into the circuit as transistors will be instantly damaged.

OPERATING PRINCIPLES

NOTE: A generator, battery, separate field relay unit, voltage regulator, and an ammeter, voltmeter, or charge indicator tell-tale are used in the system. A schematic wiring diagram of the charging circuit is shown in figure 3 in "Generating System General Description" section previously.

When ignition or engine control switch is closed and engine is not running, the field relay winding is energized causing contacts to close.

With the contacts closed, generator field current can be traced from the battery through the relay contacts to the regulator "POS" terminal. Current then continues through diode D1 and transistor TR-1 to the regulator "FLD" terminal, and then through the generator field winding to ground completing the circuit back to the battery.

When the engine is started and generator begins to operate A.C. voltages are induced in the stator windings. These voltages are changed, or rectified, to a D.C. voltage which appears at the output, or "BAT" terminal on the generator. The generator then supplies current to charge the battery and operate vehicle accessories.

As generator speed increases, the voltage reaches the pre-set value and the components in the regulator cause transistor TR-1 to alternately "turn-off" and "turn on" the generator field voltage. The regulator thus operates to limit the generator output voltage to the pre-set value.

ANALYZING CHARGING SYSTEM TROUBLES

NOTE: Procedures for analyzing or checking charging system trouble are explained previously under "On-Vehicle Maintenance, Tests, and Adjustments."

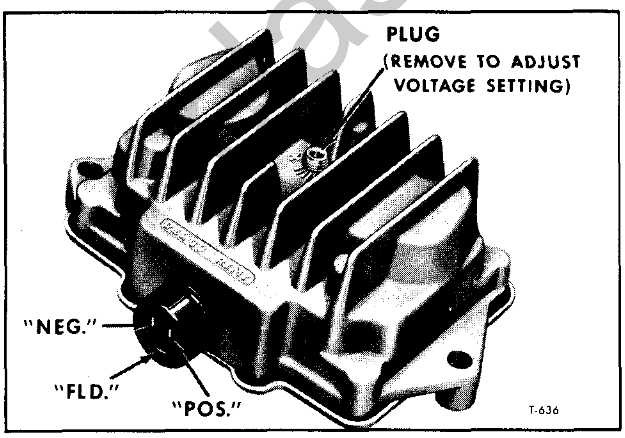


Figure 25—Full Transistor Type Regulator

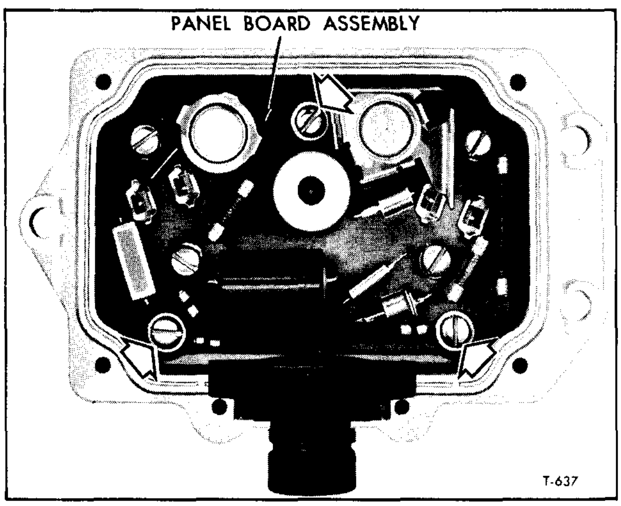


Figure 26—Regulator with Bottom Plate Removed

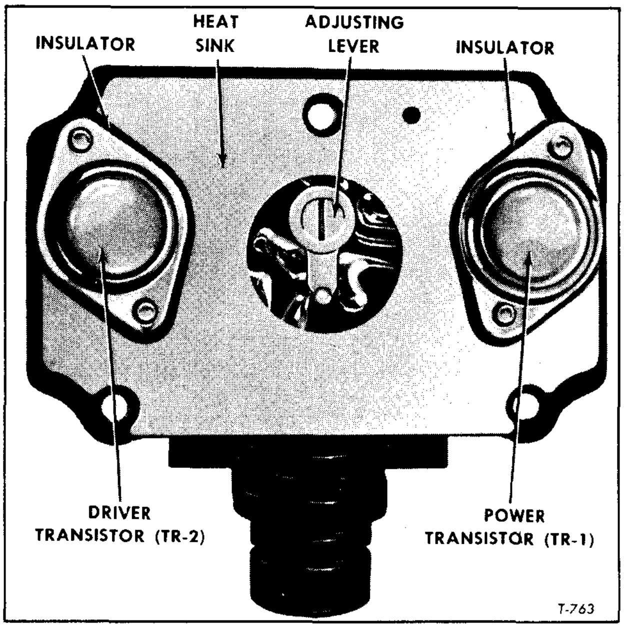


Figure 27—Top Side of Panel Board Assembly

To check circuits it is necessary to use an adapter (J-21600) at regulator.

If the trouble is located in the generator during the test procedures, refer to applicable generator section for corrective procedures.

When analyzing the system, make sure all connections between the battery, junction block, and generator, are clean and tight. Then remove the wiring harness connector from the regulator, and connect the adapter between the wiring harness connector and the regulator.

When the trouble is found, it is not necessary to make further checks; however, it is often advisable to complete all checks to insure that no other troubles exist.

The "Trouble Analysis Chart" on next page, provides a quick method of analyzing the failure, effect, and probable cause or causes.

REGULATOR REPLACEMENT

REMOVAL

1. Disconnect the negative battery cable.
2. Carefully pull wiring harness connector from regulator.
3. Remove regulator mounting screws, then remove regulator assembly.

INSTALLATION

IMPORTANT: Make sure the negative battery cable is disconnected from the battery.

1. Place regulator-generator ground wire on regulator mounting and install regulator attaching screws.

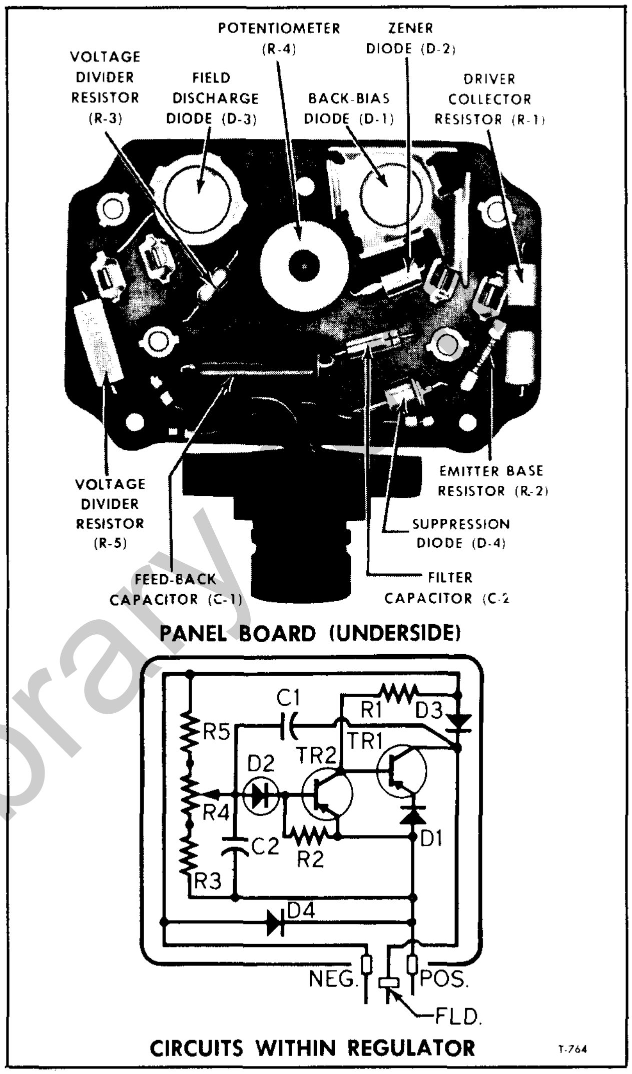


Figure 28—Under Side of Panel Board Assembly

2. Insert wiring harness connector into regulator receptacle. Make sure connector is fully engaged with terminals.
3. Connect battery cable to battery terminal.

REGULATOR REPAIR

To check the regulator for defective components, proceed as follows:

1. Remove the bottom plate from the regulator (fig. 26).
2. Remove the three panel board attaching screws identified by arrows (fig. 26), and lift the assembly from the housing.
3. To aid in reassembly, note or make any identifying markings on the two transistors and their respective locations on the panel board and heat sink assembly (fig. 28).
4. Note the insulators between the transistors

TROUBLE ANALYSIS CHART

Component Failure	System Effect	Probable Cause
Output Transistor Shorted	High system voltage, Battery overcharge, Lights burning out.	1. F terminal of generator has been grounded. 2. Poor ground in system or poor connection at generator or regulator. 3. Regulator too hot. 4. Ground in wiring between F of generator and regulator. 5. Defective transistor. 6. Shorted field in generator.
Output Transistor open emitter	No Charge	1. Severe ground at F terminal of generator. 2. Severe ground in wiring between F of generator and regulator. 3. Generator field completely shorted.
Driver Transistor Shorted	No Charge	1. Reverse battery polarity. 2. High positive transient from an external source. 3. Defective transistor.
Driver Transistor Open	High system voltage.	1. Defective transistor.
Zener Diode Shorted	No Charge	1. Reverse battery polarity. 2. High system voltage. 3. Defective zener.
Zener Diode Open	High system voltage	1. Defective zener.
Field discharge Diode open	Shorted output transistor and high svstem voltage.	1. Reverse battery polarity. 2. Defective diode.
Back bias Diode open	No Charge	1. Severe ground at F terminal of generator. 2. Severe ground in wiring between F of generator and regulator. 3. Generator field completely shorted. 4. Defective diode.
Back bias Diode shorted	Poor switching which would cause shorted output transistor.	1. F terminal of generator has been grounded. 2. Poor ground in system or poor connection at generator 3. Regulator too hot. 4. Ground in wiring between F of generator and regulator. 5. Defective transistor. 6. Shorted field in generator. 7. Defective diode.
Transient Suppression Diode open	Output transistor may short from transients - depends on application.	1. Reverse battery polarity. 2. High positive transient from external source.
Filter capacitor Open	Poor switching may or may not fail output transistor.	1. Defective connection. 2. Defective capacitor.
Feedback capacitor Shorted	High system voltage.	Defective capacitor.
Feedback capacitor Open	Poor switching which could cause shorted output transistor.	1. Poor connection. 2. Defective capacitor.
Open resistor in negative side of voltage divider. Open negative side of potentiometer.	High system voltage.	Defective resistor or potentiometer.
Open resistor in positive side of voltage divider. Open positive side of potentiometer.	No Charge	Defective resistor or potentiometer.
Open collector load resistor	No Charge	Defective resistor.
Open driver emitter - base resistor	Poor switching which will short output transistor. High system voltage.	Defective resistor.

and the heat sink, and the insulators separating the heat sink from the panel board (fig. 28).

5. Remove the transistor attaching screws, and separate the transistors and heat sink from the panel board.

With the transistors separated from the assembly, an ohmmeter may be used to check the transistors and components on the panel board for defects. An ohmmeter having a 1½ volt cell, which is the type usually found in service stations, is recommended. The low range scale on the ohmmeter should be used.

If a component part of the panel board is found to be faulty, it should be replaced before proceeding with the remaining checks. A 25 watt soldering gun is recommended, and a 60% tin 40% lead solder should be used when resoldering. Avoid excessive heat which may damage the panel board. Chip away any epoxy involved, and apply new epoxy which is commercially available. The component parts are identified in figures 27 and 28.

In order to check the panel board assembly, it is necessary to unsolder the emitter-base resistor at location shown in figure 29.

In all of the following checks, connect the ohmmeter as shown, then reverse ohmmeter leads to obtain two readings.

NOTE: Refer to figures 27 and 28 for identification and location of following components:

FEED-BACK CAPACITOR (C1), (Part A, Fig. 29)

If both readings are zero, the capacitor is defective. Visually inspect for open soldered connections and broken leads.

FILTER CAPACITOR (C2), (Part B, Fig. 29)

If both readings are zero, the capacitor is defective. Visually inspect for open soldered connections and broken leads. To assemble a new capacitor properly, note location of the "+" identifying mark in figure 28.

SUPPRESSION DIODE (D4), (Part C, Fig. 29)

If the two readings are identical, the diode is faulty.

ZENER DIODE (D2), Part D, Fig. 29)

Replace the diode if both readings are zero, or if both readings are infinite.

BACK-BIAS DIODE (D1), (Part E, Fig. 29)

Replace the diode if both readings are zero, if both readings are infinite, or identical.

FIELD-DISCHARGE DIODE (D3), (Part F, Fig. 29)

Replace the diode if both readings are zero, if both readings are infinite, or if both are identical.

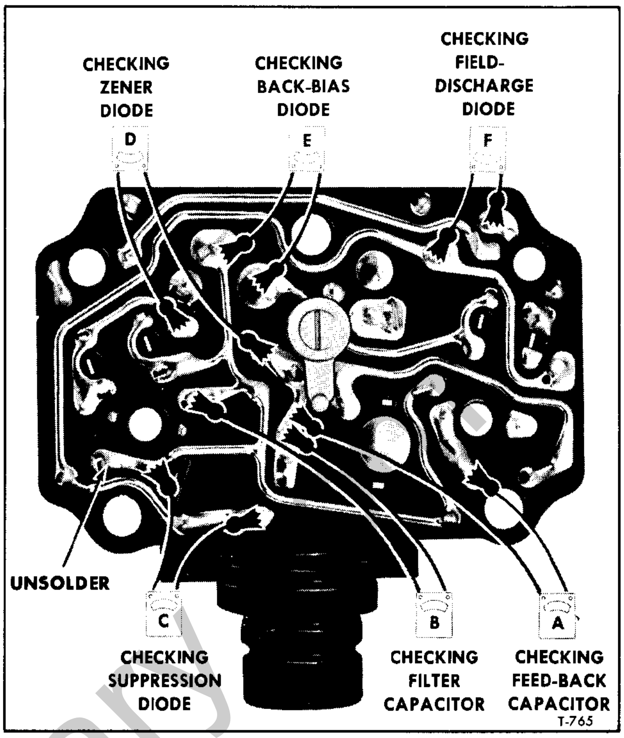


Figure 29—Checking Regulator Circuits

DRIVER-COLLECTOR RESISTOR (Part A, Fig. 30)

If both readings are infinite, the resistor is open.

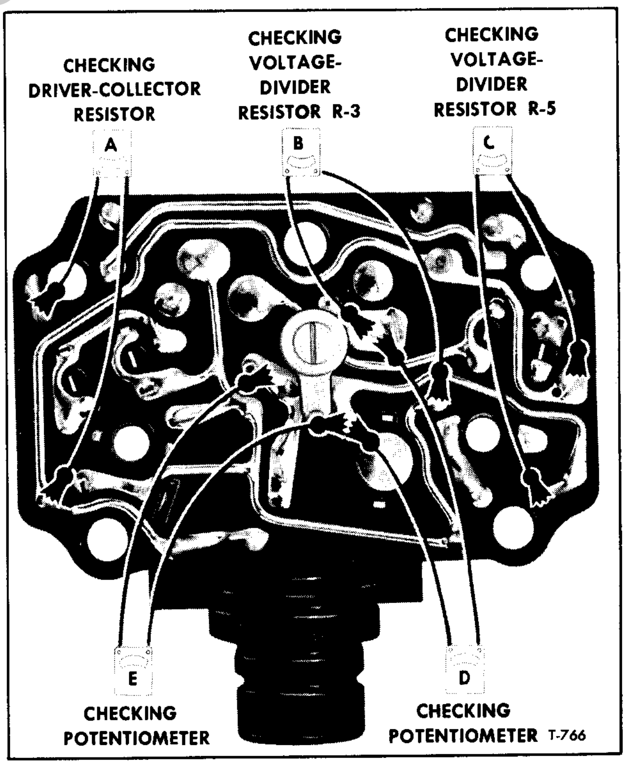


Figure 30—Checking Regulator Circuits

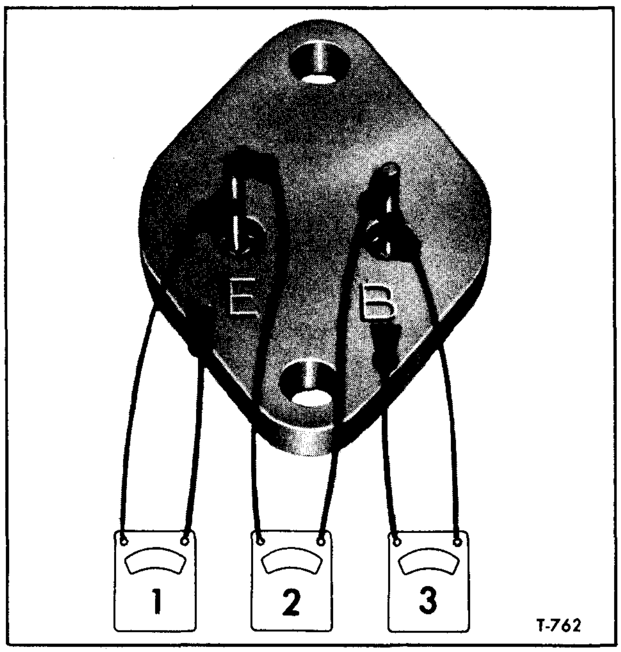


Figure 31—Checking Transistors for Shorts

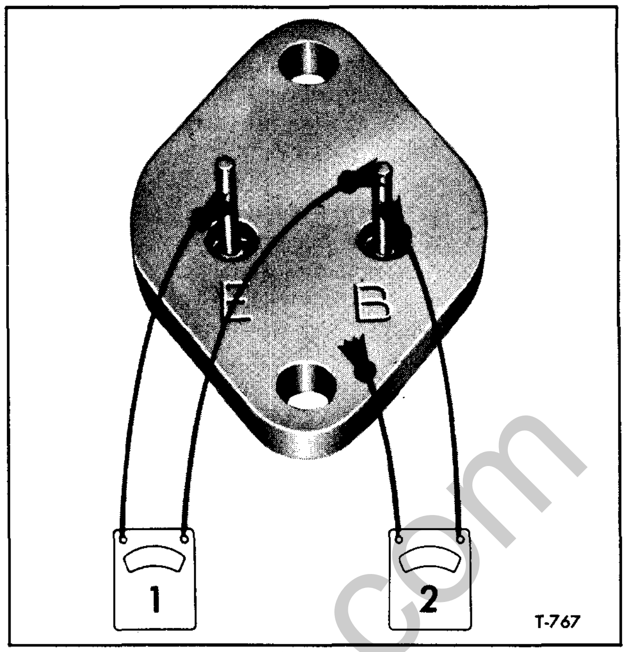


Figure 32—Checking Transistors for Opens

VOLTAGE-DIVIDER RESISTOR (R3),
(Part B, Fig. 30)

If one reading is infinite or nearly infinite, or if both readings are infinite or nearly infinite, the resistor is open.

VOLTAGE DIVIDER RESISTOR (R5),
(Part C, Fig. 30)

If one reading is infinite or nearly infinite, or if both readings are infinite or nearly infinite, the resistor is open.

POTENTIOMETER. (Parts D and E, Fig. 30)

If one reading is infinite or nearly infinite in Part D, the potentiometer is open. If both readings are infinite in Part E, the potentiometer is open.

NOTE: When installing a new potentiometer, locate the adjusting lever in a vertical position (fig. 28), turn the potentiometer resistance adjustment to the middle position, then use a soldering iron to melt the lever into potentiometer.

EMITTER-BASE RESISTOR
(OHMMETER CHECK NOT ILLUSTRATED)

Since this resistor has been unsoldered from the panel board at one end, merely connect an ohmmeter across the resistor - an infinite reading indicates an open. Replace if defective.

DRIVER AND POWER TRANSISTORS
(Refer to Fig. 31)

If both readings in Step 1 are zero, or if both readings are very low and identical, the transistor is shorted. Similarly, if both readings in Step 2, or in Step 3, are zero or very low and identical, the transistor is shorted.

DRIVER AND POWER TRANSISTORS
(TR-1 AND TR-2), (Refer to Fig. 32)

If both readings in Step 1 are infinite, or if both readings are very high and identical, the transistor is open. Similarly, if both readings in Step 2 are infinite or very high and identical, the transistor is open.

REASSEMBLY AND FINAL CHECK

During assembly, coat with silicone grease both sides of the flat insulators used between the transistors and heat sink, and also the heat sink on the side on which the transistors are mounted. The silicone grease increases heat conduction.

TROUBLE ANALYSIS CHART

CHARGING SYSTEM TROUBLE ANALYSIS CHART

BATTERY UNDERCHARGED OR DEAD

1. Faulty drive belt tension adjustment.
2. Faulty wiring, connector, or connection.
3. Faulty generator.
4. Faulty voltage regulator.
5. Faulty battery.
6. Incorrect generator application.
7. Accessories left on with engine off.

BATTERY OVERCHARGED

Check for:
1. High voltage regulator setting.
2. Excessive voltage drop in sensing circuit.

VISUAL INSPECTION

1. Check for loose generator mounting.
2. Check generator drive belt tension.
3. Check wiring and clean connectors and connections at generator, regulator, and battery.
4. Check for accessories left on or shorted wiring.

PRELIMINARY TEST

With ignition switch "OFF" connect voltmeter between "BAT" terminal on generator and chassis ground.

Disconnect "NEG" battery cable and connect test light from cable to "BAT" terminal. If light is "ON" wiring is shorted or an accessory is on.

If a voltmeter reading is obtained, record reading and proceed as follows:
Start engine (accessories "OFF") and operate at approximately 1500 RPM.

If voltmeter DOES NOT register, circuit is open between battery and generator.
NOTE: Refer to Wiring Diagram Manual for wiring circuits.

Check generator (on vehicle) since an open circuit could result in damage to generator diodes.

If voltage reading was the same or lower, failure of the following is indicated:

1. Worn or sticking generator brushes.
2. Open circuit to generator field.
3. Open or shorted generator field.

To determine fault - Proceed as directed under applicable regulator chart following.

If voltmeter reading was higher than previous, regulator circuit is satisfactory. FAULT IS:
1. Low regulator setting.
2. Faulty battery.
3. Faulty generator.
4. Incorrect generator application.

1. Charge and check the battery.
2. Check for low regulator or setting.
3. Check generator (on vehicle) for defective diode or stator.
4. Check for incorrect generator application. Consider type of driving or accessories added.

TROUBLE ANALYSIS CHART (CONT.)

CHARGING SYSTEM TROUBLE ANALYSIS CHART (EXCEPT 9000590 REGULATOR)

Load battery with a carbon pile or with heater and head lamps on. Disconnect wire from field terminal at generator. Momentarily (not more than 10 seconds) connect a jumper from generator "BAT" terminal to field "F" terminal.

If voltage reading increased:
Defective regulator or wiring is indicated.
Proceed as follows:
Remove jumper lead and reconnect wire to generator field terminal. Connect voltmeter "POS" lead to No. 3 regulator terminal and "NEG" voltmeter lead to "F" terminal on regulator.

If voltage remains low -
FAULT IS:
1. Worn or dirty brushes.
2. Open or shorted generator field.

If voltmeter reads "O" or low, connect voltmeter between No. 3 regulator terminal and chassis ground.

If high voltmeter reading was obtained, regulator is open. Repair or replace regulator.

If a voltmeter reading was obtained, connect voltmeter leads between No. 2 regulator terminal and chassis ground.

If voltmeter reading is "O" wiring is open between battery and No. 3 regulator terminal.

If voltmeter reading was obtained, generator field relay is defective. Repair or replace regulator.

If voltmeter reading was "O" wiring is open to No. 2 regulator terminal.

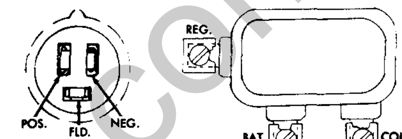
TROUBLE ANALYSIS CHART (CONT.)

CHARGING SYSTEM TROUBLE ANALYSIS CHART WITH 9000590 REGULATOR

Load battery with a carbon pile or with heater and head lamps on. Disconnect wire from field terminal at generator. Momentarily (not more than 10 seconds) connect a jumper from generator "BAT" terminal to field terminal

If voltage reading increased:
Defective regulator, wiring or field relay is indicated.
Proceed as follows:
Remove jumper lead, then remove wiring connector from regulator and connect voltmeter "POS" lead to "POS" terminal in wiring connector and "NEG" voltmeter lead to field terminal in connector.

If voltage reading remains low:
FAULT IS:
1. Worn or dirty brushes.
2. Open or shorted generator field.



WIRING CONNECTOR

1115841 RELAY

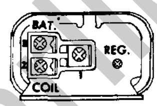
If voltmeter reading is "O" wiring or field relay is open.
1. Between field terminal of regulator and generator field.
2. Circuit is open between "POS" terminal of wiring connector and field relay.
3. Field relay is defective.
Proceed as follows:
Locate field relay unit and note Part Number. Connect voltmeter "POS" lead to relay "BAT" terminal and "NEG" lead to ground.

If voltmeter reading is obtained, voltage regulator is open or ground circuit is defective.
Proceed as follows:

Remove "NEG" voltmeter lead from regulator wiring connector and connect to "NEG" terminal of wiring connector.

If reading is "O," ground wire to regulator is open.

If voltmeter reading is obtained, a defective regulator is indicated. Remove regulator and repair.



1115827 RELAY

If voltmeter reading is obtained, connect "POS" voltmeter lead to regulator terminal of field relay.

If voltmeter reading is "O," wiring is open between relay terminal and battery.

If voltmeter reading is obtained, connect voltmeter "POS" lead to coil terminal of field relay.

If voltmeter reading is "O," wire from relay terminal to regulator terminal is open.

If voltmeter reading is "O" wiring is open between field relay terminal and ignition switch on vehicles equipped with the 1115841 field relay or to "R" terminal of generator on vehicles equipped with the 1115827 field relay.

If voltmeter reading was obtained, field relay is defective. Remove relay and replace.

NON-INTEGRAL TYPE ALTERNATING CURRENT GENERATOR SPECIFICATIONS

TWO-UNIT TYPE VOLTAGE REGULATOR
(MODEL 1119507 AND 1119515)

Make	Delco-Remy	Delco-Remy
Model	1119507	1119515
Field Relay		
Air Gap (In.) (a)	0.015	0.015
Point Opening (In.)	0.030	0.030
Closing Voltage Range	3.8-7.2	1.5-3.2
Voltage Regulator		
Air Gap (In.) (Approx.) (b)	0.067	0.067
Point Opening (In.)	0.014	0.014
Voltage Chart	No. 1	No. 1

(a) Tolerance Plus or Minus 20%
(b) Make Final Adjustment as Per Text

TEMPERATURE—VOLTAGE CHART* NO. 1

Degrees F.	65	85	105	125	145	165	185
Voltage Setting	13.9-15.0	13.8-14.8	13.7-14.6	13.5-14.4	13.4-14.2	13.2-14.0	13.1-13.9

*Operation on lower contacts must be 0.1-0.4 Volt lower than on upper contacts.

TRANSISTORIZED TYPE VOLTAGE REGULATOR
(MODEL 1116374 AND 1116378)

Make	Delco-Remy	Delco-Remy
Model	1116374	1116378
Field Relay		
Closing Voltage Range	4.5-6.5	2.0-3.0
Voltage Chart (a)	No. 2	No. 2

(a) Allowable Range at "0" Position of Adjusting Screw.

TEMPERATURE—VOLTAGE CHART NO. 2

Regulator Ambient Temp. (Deg. F.)	65	85	105	125	145	165	185
Voltage Setting	14.1-14.8	13.9-14.7	13.7-14.5	13.6-14.3	13.4-14.2	13.2-14.0	13.1-13.8

FULL TRANSISTOR TYPE VOLTAGE REGULATOR
(MODEL 9000590)

Make	Delco-Remy
Voltage Setting*	13.7-14.3

*Allowance Range at "0" Position of Adjusting Screw.

ALTERNATING CURRENT GENERATOR SPECIFICATIONS

GENERATOR MODEL	1100842	1100849	1117754 1117756	1117128
Make	Delco-Remy	Delco-Remy	Delco-Remy	Delco-Remy
Rotation (Viewing Drive End)	Clockwise	Clockwise	Clockwise	Clockwise
Brush Spring Tension (oz.)	—	—	—	10
Field Current at 80°F				
Amps	2.2—2.6	2.2—2.6	4.14—4.62	2.22—2.40
Volts	12	12	12	12
Cold Output at Specified Volts				
Volts	14.0	14.0	14.0	14.0
Amps	28	33	20(a)	40(a)
Generator RPM (Approx.)	2000	2000	1100	1100
Amps	40	58	55(a)	126(a)
Generator RPM (Approx.)	5000	5000	2500	2500
Rated Hot Output	42	61	62	130

(a)If generator output is checked without a regulator, the output should be 5—10% higher than the value given.

NON-INTEGRAL TYPE ALTERNATING CURRENT GENERATOR SPECIFICATIONS (CONT.)

FIELD RELAY UNIT SPECIFICATIONS

Relay Model	**1115827**	**1115841**
Make	Delco-Remy	Delco-Remy
Air Gap at Core (Points closed) (In.)	0.011-0.018	0.012
Point Opening (In.)	0.020-0.030	0.015-0.025
Closing Voltage Range	2.5-3.5	7-8
Sealing Voltage Range	0-1 Volt-above closing	10 Max.

ALTERNATING CURRENT GENERATOR TORQUE SPECIFICATIONS

ITEM	TYPE OF PART	TORQUE (FT. LBS.)
Generator Pulley Nut	Nut	55-65
Generator Adjusting Arm Pivot Bolt		
With 42-Amp. Generator	Bolt	15-20
With 61-Amp. Generator	Bolt	20-25
With 62-Amp. Generator	Bolt	25-30
With 130-Amp. Generator	Bolt	30-35
Generator to Mounting Bracket Pivot Bolt		
With 42-Amp. Generator	Nut	15-20
	Bolt	25-30
With 61-Amp. Generator	Nut	15-20
	Bolt	30-35
With 62-Amp. Generator		
Conventional Cab Models	Bolt	50-60
Tilt Cab Models	Nut	35-45
	Bolt	40-50
With 130-Amp. Generator	Nut	25-30
Generator Support Bracket-to-Mounting Bracket	Bolt	40-50
Generator Mounting Bracket-to-Engine		
With 42-Amp. Generator	Nut	25-30
	Bolt	45-55
With 61-Amp. Generator	Nut	25-35
	Bolt	45-55
With 62-Amp. Generator		
Conventional Cab Models		
Rear Bracket	Bolt	45-55
Front Bracket	Bolt	30-35
Tilt Cab Models	Bolt	40-50
With 130-Amp. Generator	Bolt	40-50

INTEGRAL TYPE ALTERNATING CURRENT GENERATING SYSTEM

The integral (generator with solid state regulator built in) alternating current type generator is used as standard and optional equipnebt on vehicles shown in the model application chart below:

Refer to "Model Application Chart" below and "Specifications" at end of this section. This section is divided into sub-sections shown in the Index following:

MODEL APPLICATION CHART

AMPERAGE	TRUCK SERIES	GENERATOR
STANDARD		
75-Amp Delco-Remy	DC/DN/FC/FN-90	1117225
75-Amp Delco-Remy	DH/DI/FH/FI-90	1117231
OPTIONAL		
105-Amp Leece Neville	DH/DI/FH/FI-90	655988

STANDARD 75-AMP. DELCO-REMY INTEGRAL TYPE GENERATING SYSTEM

GENERAL DESCRIPTION

The basic charging system components include the battery, the self-rectifying, integral type alternating current generator having a built-in regulator, and interconnecting wiring. An ammeter and voltmeter type charge indicator is used on all vehicles equipped with the integral type generating system.

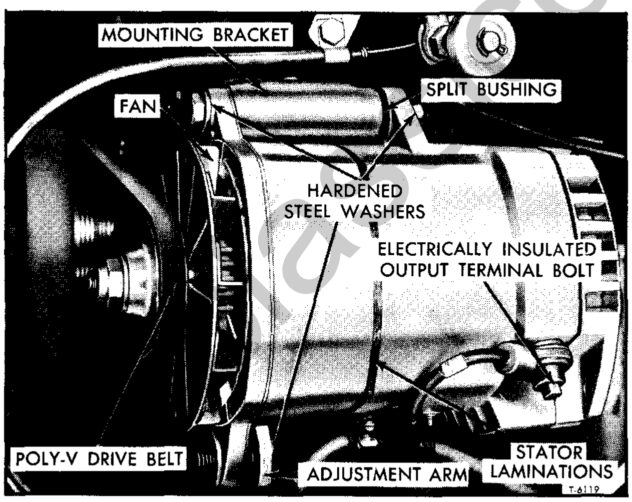


Figure 1—Standard 75-Amp. Integral Type Generator Installed (Typical)

The generator illustrated in figures 1 and 2 features a solid state regulator mounted inside the generator slip ring end frame. All regulator components are enclosed in a solid mold. This unit, along with the brush holder assembly, is attached to the slip ring end frame. The regulator voltage setting can be adjusted as explained later in this section.

The generator is air-cooled by a fan attached to the drive end. The rotor bearings contain a supply of lubricant sufficiently adequate to eliminate the need for periodic lubrication. Two brushes carry current through the two slip rings to the field coil mounted on the rotor shaft.

The stator is composed of a large number of windings assembled on the inside of a laminated core that forms a part of the generator frame. A rectifier bridge connected to the stator windings contains six diodes, and electrically changes the stator A.C. voltage to a D.D. voltage which appears at the generator output terminal. Generator field current is supplied through a diode trio connected to the stator windings. A capacitor, or condenser, mounted in the end frame, protects the rectifier

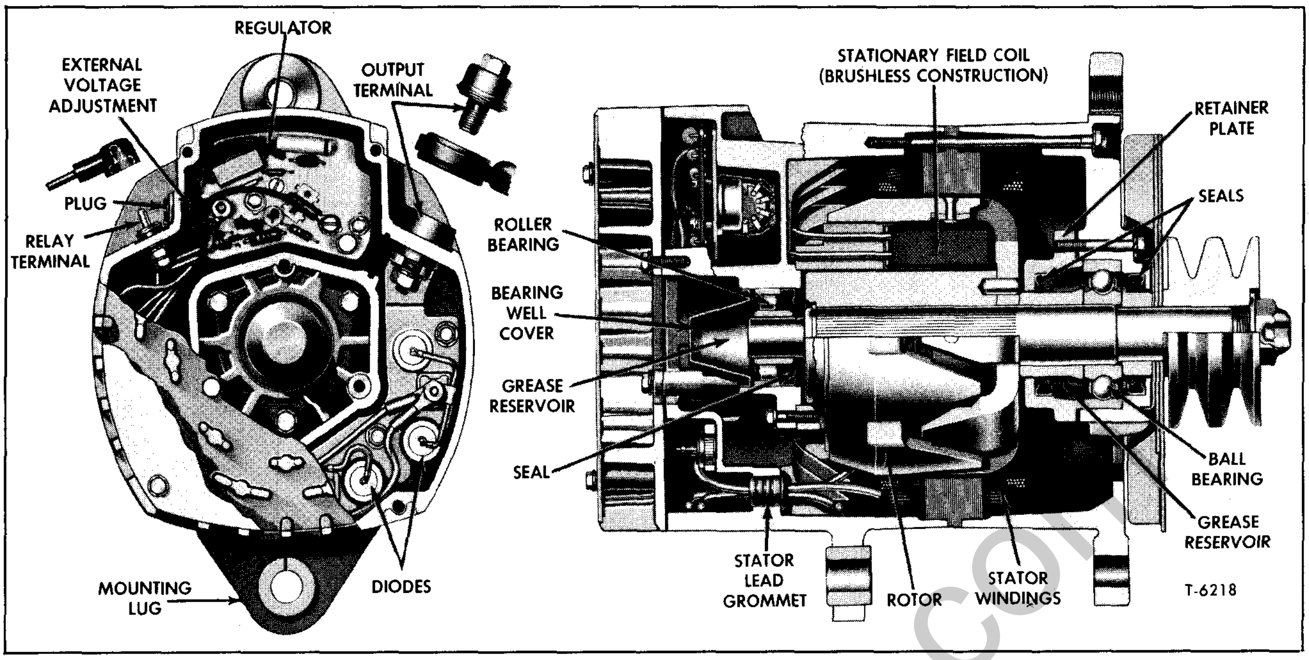


Figure 2—Cross Section of 75-Amp. Integral Type Alternating Current Generator (Typical)

bridge and the diode trio from high voltage and suppresses radio noise.

The specially designed output terminal is connected directly to the battery. The red output terminal lead must be connected to the battery positive terminal.

NOTE: The hex head bolt on the output terminal is electrically insulated; therefore, no voltage reading can be obtained by making test connections at the hex head bolt.

A typical generating system used on vehicles equipped with the integral type alternating current generator is schematically illustrated in figure 3.

NOTE: On vehicles equipped with the Cummins Diesel engine, a frequency sensing relay is fed from the generator "R" terminal. For information relative to this relay, refer to "Starter Automatic Disengagement and Lock Out" in "STARTING SYSTEM" previously.

PRECAUTIONS

Observe the following precautions when performing service operations on the integral type alternating current generating system. Failure to observe these precautions may result in serious damage to the charging system.

1. Electrical system is negative ground. Connecting the battery or battery charger with positive terminal grounded will endanger generator diodes and vehicle wiring by high current flow. Burned wiring harnesses and burned "Open" diodes will result.

2. Never operate the generator on an open circuit (field terminal connected and output terminal disconnected). With no battery or electrical load in the circuit (open circuit) the generator can build up excessively high voltage. Be sure all connections in the charging circuit are secure.

3. The generator cannot be polarized. Any

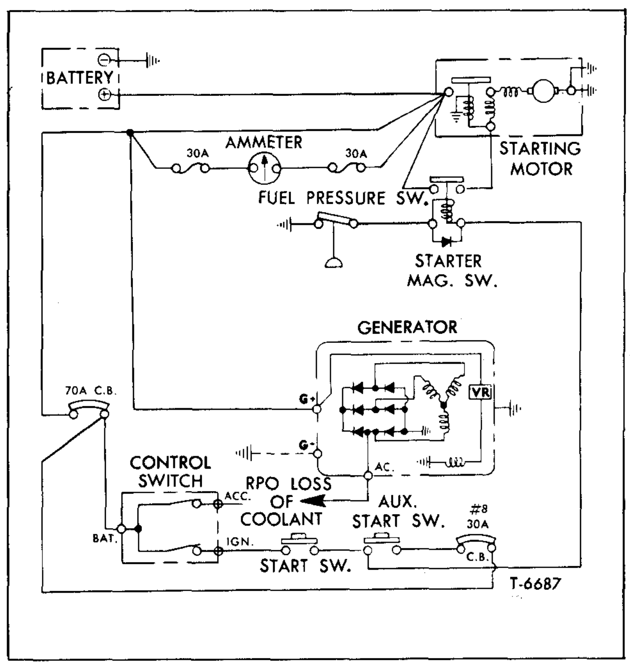


Figure 3—Schematic Diagram of Integral Type AC Charging Circuit (with 75-Amp. Generator) (Typical)

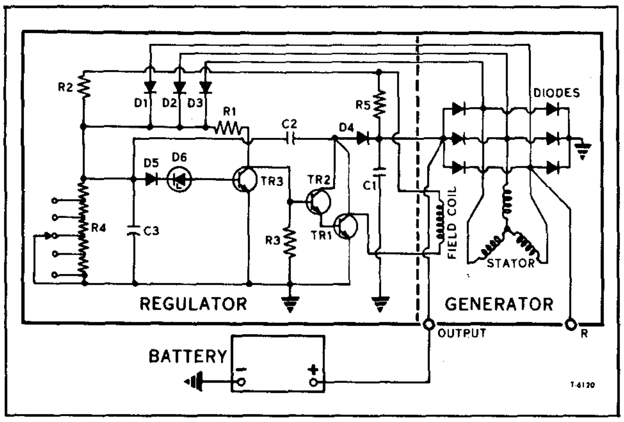


Figure 4—Generator and Regulator Circuitry

attempt to polarize the generator may result in serious damage to charging system components.

4. Before replacing electrical system components, disconnect negative battery cable from battery to prevent accidental shorting at generator terminals where battery voltage is available.

5. Do not short across or ground terminals on the generator.

6. When using a booster battery, be sure to connect negative battery terminals together and positive terminals together.

7. Disconnect battery leads while charging batteries. Do not use a fast charger as a booster for starting the engine. When attaching battery charger leads to the battery, connect charger positive lead to battery positive terminal and charger negative lead to battery negative terminal.

VOLTMETER

These vehicles are equipped with voltmeter-type charge indicator which, when properly observed, will provide a continuous indication of the battery and electrical system condition and should warn of over- or under-charging in advance of battery failure.

During normal operation, the voltmeter reading will range from 13.5 to 14.0 volts. If the battery is discharged to any extent, the reading may be as low as 12.0 to 13.0 volts although the generator is charging properly. In no instance should the voltmeter register above 14.5 to 15.0 volts. If this happens or if the reading remains at the low end of the scale for an extended period, the charging system should be inspected as outlined later.

OPERATING PRINCIPLES

A typical diagram showing generator and regulator internal circuitry is shown in figure 4. As the rotor begins to turn, the residual magnetism therein induces voltages in the stator windings. Current then flows through the diodes D1, D2, and D3, resistors R1 and R3, and the generator diodes back to the stator winding. The transistors TR1 and TR2 then turn on, and the battery supplies current through resistor R5 the field coil, and TR1. As system voltage increases, a voltage across R4 is impressed across diodes D5 and D6, caused by current flow through R5, R2, and R4. When the pre-set voltage is reached, diodes D5 and D6 conduct, TR3 turns on, TR1 and TR2 turn off, and the generator voltage decreases. Diodes D5, D6, and TR3 then turn off, TR1 and TR2 turn back on, and the cycle repeats many times per second to limit the generator voltage to the adjusted value.

Diode D4 prevents high field-coil-induced voltages when TR1 and TR2 turn off.

Capacitor C3 smooths out the voltage across R4. Resistor R5 raises the generator voltage slightly as generator output increases to maintain a more nearly constant voltage across the battery by compensating for line drop.

Capacitor C1 protects the generator diodes from high transient voltages, and suppresses radio interference.

GENERATING SYSTEM MAINTENANCE

Most charging system troubles show up as an undercharged or overcharged battery. Since the battery may be defective, it should be checked first to determine its condition. In the case of an undercharged battery, check for battery drain caused by grounds or by accessories being left on.

IMPORTANT: Keep generator terminals and all other terminals in electrical system clean and tight. A loose or corroded terminal will cause excessive resistance in system which will result in hard starting, dim lights, etc.

At regular intervals, inspect generating system to locate and correct potential causes of trouble before generating system performance is affected.

1. Check generator drive belt tension and adjust if necessary. Refer to procedure later under "Generator Drive Belt Tension Adjustment."

2. Check generator mounting and adjusting arm bolts and tighten as necessary.

3. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition and that all wiring is securely clipped to prevent chafing the insulation.

4. With engine running, listen for noise and check generator for vibration. If generator is noisy or vibrates excessively, it should be removed for inspection and repair.

5. Check battery electrolyte level and specific gravity. Replenish electrolyte level as necessary.

GENERATOR DRIVE BELT

Because of the higher inertia and load capacity of the rotor used with the A.C. generator, proper belt tension must be maintained.

A loose or broken drive belt will affect operation of the generator. A belt that is too tight will place excessive strain on bearings.

IMPORTANT: When adjusting drive belt tension, apply pressure against center of generator, never against either end frame.

NOTE: On a new vehicle, or after having installed a new drive belt, check tension of belt twice in first 200 miles of operation. Before adjusting the drive belt, examine the belt and replace if frayed or worn.

BELT TENSION ADJUSTMENT
(EXCEPT POLY-V BELT)

The generator is pivot-base mounted with the belt tension adjustment arm at the top. Use a suitable belt tension dial gauge to check tension on each individual belt. If tension is not within 80-90 lbs. (used belts) or 100-110 lbs. (new belts), loosen adjustment arm clamp bolt and generator pivot bolts, then move generator to obtain recommended tension. Tighten clamp bolt and pivot bolt firmly.

BELT TENSION ADJUSTMENT
(POLY-V BELT)

Use a Borroughs Poly-V Belt Tension Gauge (BT-33-86AE-2-26-A) to check tension on Poly-V belt as shown in figure 5. If tension is not within specified limits (84 to 94 lbs. on 8V-71 Diesel Engine or 44 to 54 lbs. on 6-71 Diesel Engines) loosen the adjustment arm clamp bolt and generator pivot bolt, then apply pressure to center of generator to obtain recommended tension. This can usually be done with tension gauge on the belt. Tighten generator pivot bolt and adjustment arm clamp bolt firmly.

TROUBLESHOOTING PROCEDURES

GENERAL INFORMATION

Energizing Speed

The energizing speed is the rpm at which the regulator turns on to energize the field coil. This speed is higher than some speeds at which output can be obtained. Therefore, when checking output at low speeds, increase the speed until the regulator turns on, then reduce the speed to check the output. No output can be obtained until the regulator turns on. Once the regulator turns on, it will remain turned on until the engine is stopped.

Rated Voltage

The generator output preferably should be checked at the "Rated Voltage" given in following table.

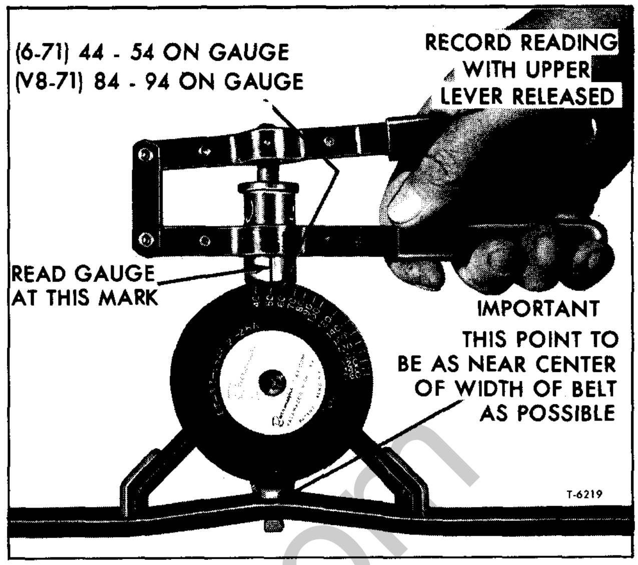


Figure 5—Poly-V Belt Tension Adjustment (Typical)

However, it is permissible to check the output in amperes at any voltage within the "Operating Range" listed in the table, since the current output will be quite close to the value that would be obtained at "Rated Voltage." The voltage should never be allowed to rise above the "Operating Range" at any time.

SYSTEM VOLTAGE	RATED VOLTAGE	OPERATING RANGE
12	14.0	13.0-15.0

It should be noted that the voltage may be below the "Operating Range" if the battery is in a low state of charge. However, as the battery receives a charge, the voltage will rise to some value within the "Operating Range."

Magnetizing the Rotor

The rotor normally retains magnetism to provide voltage build-up when the engine is started.

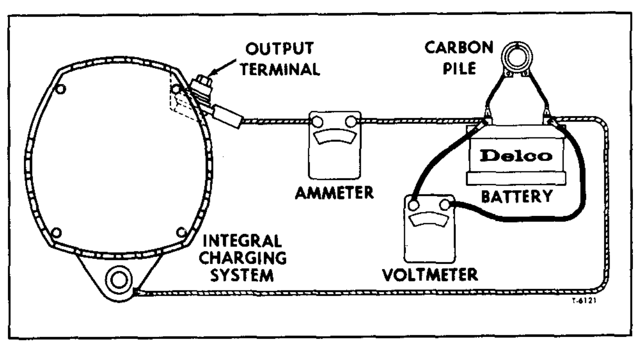


Figure 6—Generator Output Test Connections

After disassembly, replacement, or servicing, however, it may be necessary to re-establish the magnetism. To magnetize the rotor, connect the generator to the battery in a normal manner, then momentarily connect a jumper lead from the BATTERY POSITIVE POST TO THE GENERATOR RELAY TERMINAL, identified in figure 2. This procedure will restore the normal residual magnetism in the rotor.

CHARGING SYSTEM TROUBLES

IMPORTANT: Disconnect the negative battery cable when connecting or disconnecting generator.

Trouble in the vehicle charging system will be indicated by one of two conditions:

- An undercharged battery as evidenced by low specific gravity readings and slow cranking.
- An overcharged battery as evidenced by excessive battery water usage.

These conditions can be caused by:

1. Defective battery.
2. Poor circuit connections.
3. Defective generator.

1. Defective Battery

Since the battery may have an internal defect, it must be checked to determine its condition.

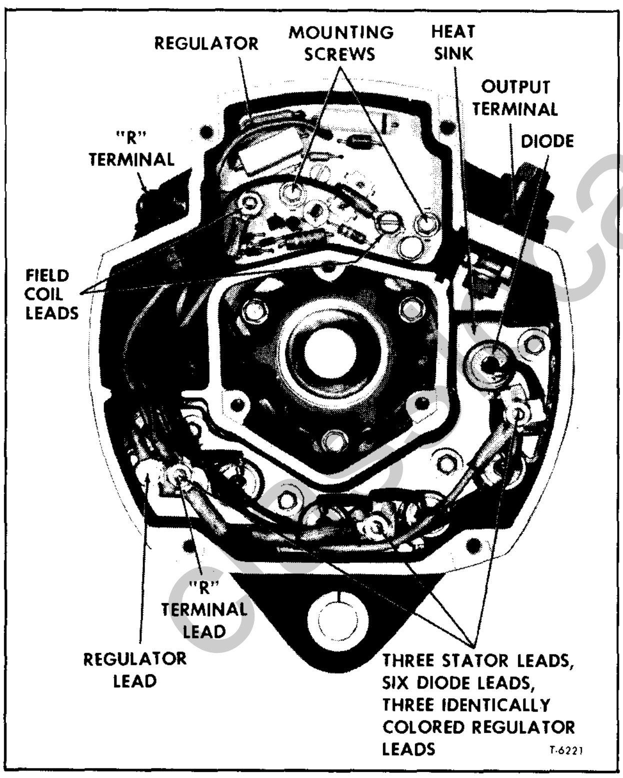


Figure 7—Generator End Frame with Cover Removed (Typical)

2. Poor Circuit Connections

Poor circuit connections can cause an undercharged condition only. Carefully inspect all connections including grounds between the generator and battery for cleanliness and tightness. Ensure that the battery cable clamps are clean and tight, and that the battery is dry and clean.

3. Defective Generator

If the battery and circuit connection checks are satisfactory, the generator may be checked either on or off the vehicle by making connections as shown in figure 5.

a. With the carbon pile turned off (open-circuited), increase the generator speed, observe the voltmeter. The "Operating Range" should be 13.0 to 15.0 volts.

If the voltage does not rise above the "Operating Range," proceed to Part b. If the voltage rises above the "Operating Range" check the regulator lead (fig. 7) for tightness. If satisfactory, check the field coil for shorts. If the field coil is shorted, replace the field coil and the regulator; however, this would require removing and overhauling the generator.

If the field coil checks satisfactorily, replace the regulator.

b. If the voltage does not rise above the "Operating Range" as covered in Part a. preceding, increase the generator speed as required, and adjust the carbon pile as required to obtain maximum current output. Observe the ammeter.

(1) If the ampere output is within 10 percent of the output stamped on the name plate, the generator is good. In this case an adjustment of the voltage setting may correct the undercharged, or overcharged condition, as follows:

(a) Remove pipe plug from generator (fig. 2).
(b) Turn adjusting screw one or two notches clockwise to raise the voltage setting for an undercharged battery.
(c) Turn adjusting screw one or two notches counterclockwise to lower the voltage setting for an overcharged battery.
(d) Replace pipe plug.

After adjusting setting, check for an improved battery condition over a service period of reasonable length. Remember that the ideal voltage setting of the regulator is one which will maintain the batteries in a fully charged condition with a minimum use of water. A record of water usage and battery specific gravity checks over a service period of reasonable length will establish the ideal voltage setting for the vehicle involved. Also, remember that if the battery state of charge is low, the regulator may not be limiting the voltage, and turning the adjusting screw will show no change on the voltmeter. However, turning the adjusting screw will change the voltage setting to a new value, which will be indicated by the voltmeter when the battery state of charge increases.

(2) If the ampere output is not within 10 percent of the output, proceed as follows:

(a) If the output is below 5 amperes, check the field coil as explained later under "Field Coil Checks." If the field coil is open, replace only the field coil; this would require removal and disassembly of alternator. If the field coil is grounded or shorted, replace both the field coil and the regulator. If field coil checks satisfactorily, replace regulator.

(b) If the output is 5 amperes or above, but not within 10 percent of the amperes output, check the field coil, stator, and diodes, as covered in the next paragraph, repair as required, and then recheck the output as previously covered.

CHECKING FIELD COIL, DIODES, AND STATOR

Remove cover plate, cover and gasket to expose rectifier end frame components as shown in figure 7. Carefully note the proper connections, then proceed as follows:

To check the field coils, disconnect the two field coil leads from the regulator.

1. Field Coil Checks (Fig. 8)

a. To check for grounds, connect a test lamp, or an ohmmeter to one field coil lead and to the end frame as illustrated. If lamp lights, or if ohmmeter reading is low, the field coil is grounded.

b. To check for opens, connect a test lamp, or an ohmmeter to the two field coil leads as shown. If the lamp fails to light, or if ohmmeter reading is high (infinite), the field coil is open.

c. The winding is checked for short-circuits by connecting a battery and ammeter in series with the field coil. Note the ammeter reading. The ammeter should read 4.1-4.5 amperes at 80°F. An ammeter reading above the specified value indicates shorted windings. An alternate method is to check the resistance of the field by connecting an ohmmeter to the field coil. If the resistance reading is below 2.65 to 2.85 ohms, the winding is shorted.

2. Diode and Stator Checks (Fig. 8) (Omit for overcharged battery)

a. To check the diodes and stator, remove the three nuts, the three regulator leads, the three stator leads, the six diode leads, and the "R" terminal lead from the three studs. During reassembly, place over each stud in this order, the two diode leads, the stator lead, the "R" terminal lead on one stud only, the regulator lead, and the nut. Check each of the six diodes by removing each diode lead from the stud and connecting a 12 volt test lamp or an ohmmeter using the lowest range scale to the diode lead and case. Then reverse the test lamp or ohmmeter lead connections to the diode lead and case. If both readings are the same, the diodes will have to be replaced. A good diode will give one high and one low reading with ohmmeter, or 12 volt test lamp will light one way and not the other.

CAUTION: DO NOT use high voltage such as 110 volt test lamps, to check diodes.

b. The stator windings may be checked with a 12-volt test lamp or an ohmmeter. If the lamp

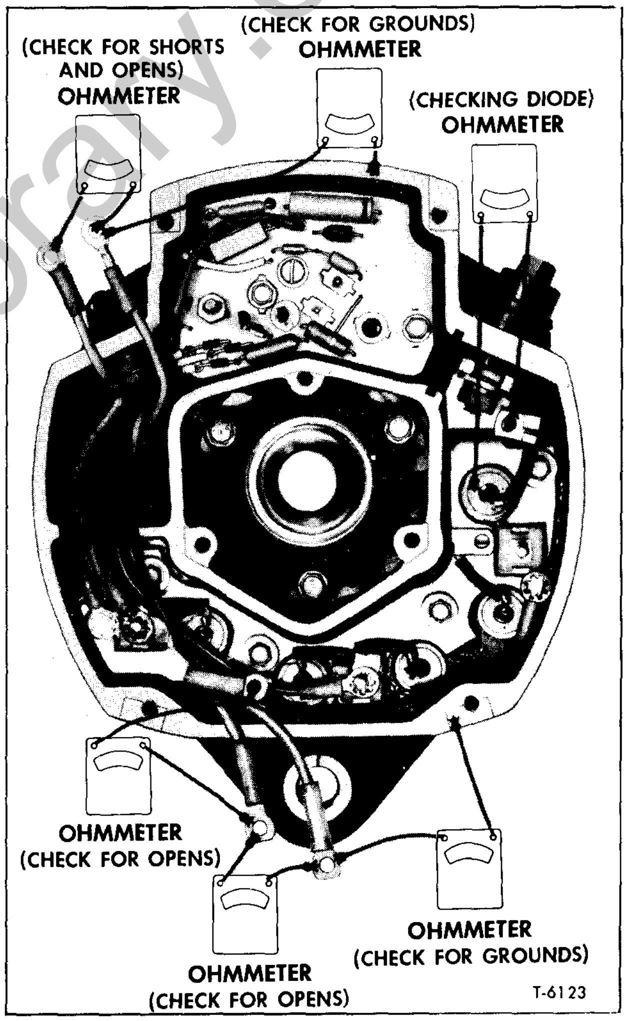


Figure 8—Electrical Checks (Typical)

lights, or if the meter reading is low when connected from any stator lead to the frame, the windings are grounded. If the lamp fails to light, or if the meter reading is high when successively connected between each pair of stator leads, the windings are open.

If the stator or diodes check bad it will be necessary to remove and disassemble the alternator.

NOTE: A short circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings are indicated.

REGULATOR REPLACEMENT (Fig. 8)

After disconnecting the three identically colored regulator leads, the regulator may be replaced by removing the attaching screws and disconnecting the regulator lead from the heat sink. When installing the regulator, refer to figure 7 for proper lead connections.

OUTPUT CHECK

After disassembly and repair, magnetize the rotor as covered under "Magnetizing The Rotor" previously in this section, then recheck the generator as covered in "Troubleshooting Procedures" earlier in this section, by making connections as shown in figure 6.

REMEMBER — The output terminal is red, connect this terminal and ammeter to battery positive post, and battery negative post to generator frame.

Torque the output terminal insulated bolt 100-110 inch-pounds when attaching cable.

GENERATOR REPLACEMENT

Due to variations in design and the equipment used, the replacement procedures will vary accordingly. The removal and installation instructions following are intended only as a guide. Additional operations will be required on some vehicles to remove other equipment to gain access to generator, drive belt, and/or brackets.

GENERATOR REMOVAL

1. Disconnect negative battery cable.

IMPORTANT: It is important that battery negative terminal be disconnected, since generator will be damaged if wiring or terminals are accidentally shorted or grounded while being disconnected.

2. Remove bolt from the electrically insulated output terminal, then remove the lead. Disconnect relay terminal lead from generator.
3. Loosen adjusting arm clamp bolt and generator to mounting bracket pivot bolt. Move generator to loosen drive belt, then remove drive belt from generator pulley.
4. Remove adjusting arm clamp bolt and mounting bracket bolt, then remove the generator.

GENERATOR INSTALLATION

IMPORTANT: Be sure negative battery cable is disconnected from battery. Failure to disconnect the cable may result in damage to generator.

NOTE: Refer to figure 1 for typical generator installation.

1. Position generator in mounting bracket and install mounting bracket pivot bolt and adjustment arm clamp bolt with hardened steel washers as shown in figure 1. Tighten pivot bolt nut firmly.
2. Place drive belt over generator drive pulley and adjust belt tension as explained under "Drive Belt Tension Adjustment" previously. Tighten mounting bracket pivot bolt and adjustment arm clamp bolt to torque recommended in "Specifications" at end of this section.
3. Place output terminals on output terminal bolt and install. Tighten the hex head bolt firmly. Press relay terminal lead over relay terminal.
4. Connect negative battery cable to battery, then perform "Generator Output Test" described previously to determine if generator is operating properly and regulator is correctly adjusted.
5. Install protective shield over generator drive pulley.

OPTIONAL 105-AMP. LEECE-NEVILLE INTEGRAL TYPE GENERATING SYSTEM

NOTE: Information applicable to generator drive belt tension adjustment remains the same as covered under "Standard 75-Amp Delco-Remy Integral Type Alternating Current Generating System" previously.

GENERAL DESCRIPTION

This generator, used as optional equipment on some vehicles, is cooled by a single fan attached to a drive pulley.

The generator consists of two major parts: A stator and a rotor. The stator is composed of a large number of windings assembled on the inside of a laminated core attached to the generator frame. Two brushes carry current through slip rings to coils which are wound concentric with the rotor shaft.

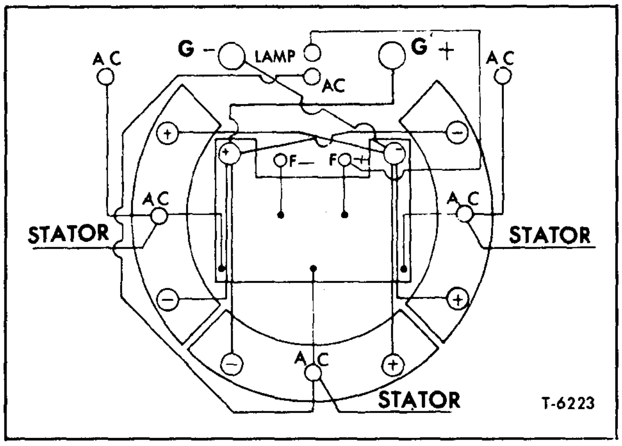


Figure 9—Schematic Diagram Viewing Slip Ring End Frame

The alternating current produced within the generator is rectified by six silicone rectifier diodes mounted in the slip ring end housing and internally connected to the stator windings. Direct current is produced at output (G+) terminal on generator. See Wiring Diagram shown in figure 9.

The internal regulator controls generator voltage output by varying the current flow in field windings in generator rotor assembly. No current regulating device is required in the regulator used with the A.C. generator, since the generator has inherent current regulation as long as the voltage is controlled.

ON-VEHICLE MAINTENANCE

The following items should be checked periodically to ensure proper operation of the generator and to aid in locating potential causes of trouble before generator performance is seriously affected.

1. Check generator drive belt tension and adjust if necessary. See procedure previously under "Generator Drive Belt Tension Adjustment."

NOTE: If generator fan can be rotated by pulling on fan blade with one finger, the drive belt is too loose and must be tightened.

2. Check generator mounting bolts, pivot bolts, and adjustment arm clamp bolt and tighten as necessary.

3. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition and that all wiring is securely clipped to prevent chafing the insulation.

4. With engine running, listen for noise and check generator for vibration. If generator is noisy or vibrates excessively, it should be removed for inspection and repair.

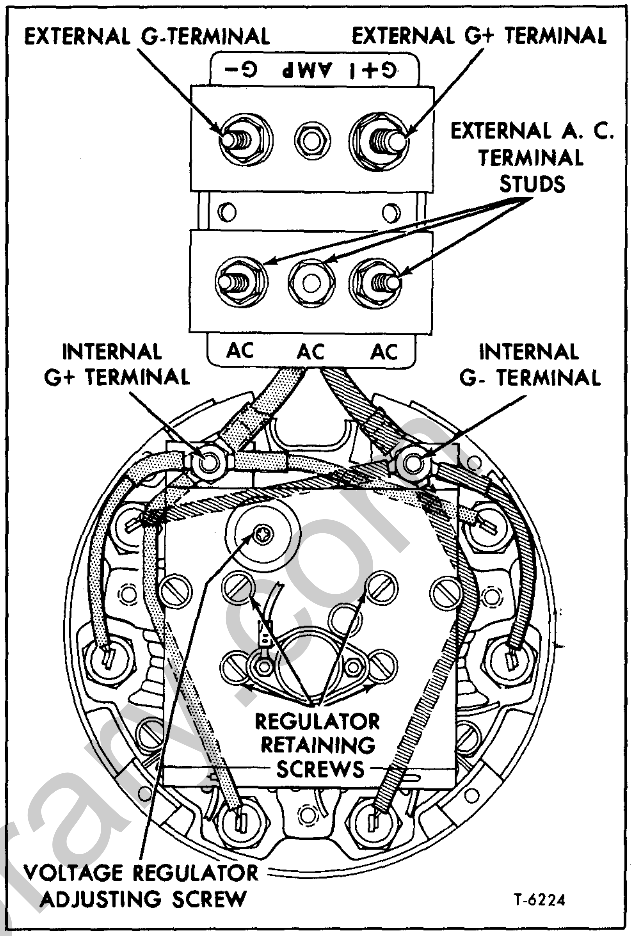


Figure 10—Generator Terminals and Wiring Connections (105-Amp. Generator)

ON-VEHICLE TESTS

NOTE: BE SURE BATTERY IS FULLY CHARGED WHEN MAKING TESTS ON VEHICLE TO OBTAIN ACCURATE READINGS FROM TESTS.

GENERATOR OUTPUT TEST

1. Disconnect negative terminal at battery or batteries.

2. Disconnect external (G+) lead from generator (fig. 10) and install ammeter in series with (G+) terminal on generator and the lead disconnected from (G+) terminal.

3. Connect battery and install voltmeter and carbon pile at battery.

4. Start engine and run at 800 rpm. Load carbon pile until battery voltage falls to 13.5 volts. Ammeter should register approximately 95 amps.

NOTE: If output is not within specifications, check all wiring and connections, then repeat test. If test still is not satisfactory, perform other test outlined following to locate trouble.

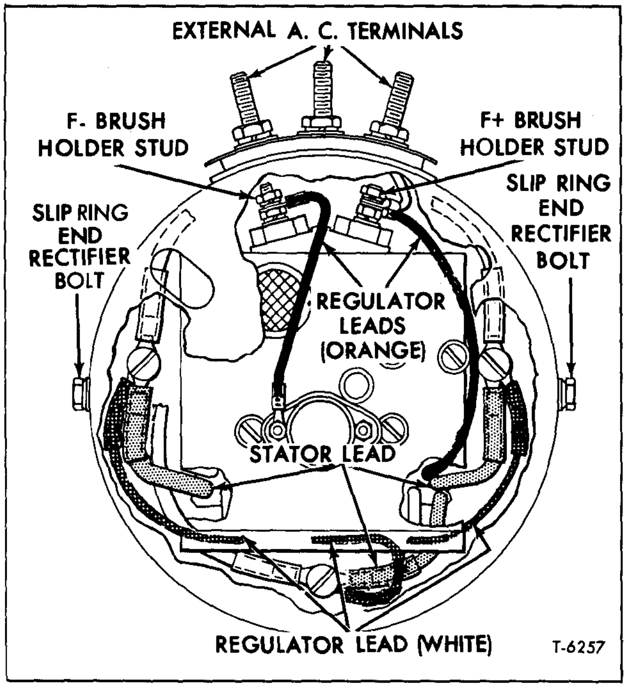


Figure 11—Regulator Terminals and Wiring Connections (Typical)

REGULATOR VOLTAGE TEST

NOTE: This test will determine whether the generator or regulator is at fault when there is insufficient output.

1. Disconnect negative terminal at battery until ready to start engine.
2. Loosen two bolts and remove slip ring end rectifier cover (fig. 11).
3. Disconnect field lead from (F-) brush holder stud (fig. 11).
4. Connect external ground jumper wire to (F-) brush holder stud.

NOTE: Unit is now full-fielded and will have no voltage control.

CAUTION: DO NOT EXCEED 1700 RPM GENERATOR SPEED (500-600 ENGINE RPM).

5. Install suitable ammeter in series at (G+) external terminal (fig. 10), and voltmeter across battery terminals.

NOTE: Remove all external load from the battery by turning off all accessories, wince with constant full-field, voltage can exceed 15 volts.

6. Connect battery, start engine and run at idle speed. If there is not a positive ammeter reading and battery voltage does not start to rise in a few minutes, proceed to Step 7.

NOTE: If there is a positive ammeter reading and battery voltage does rise, generator is good and regulator is faulty. Replace regulator as described later in this section and re-run output test.

CAUTION: DO NOT short or ground generator terminals.

7. Connect a jumper wire from (G+) terminal (fig. 11) to (F+) brush holder (fig. 10) after removing existing two wires.

NOTE: Leave ground jumper connected.

8. Repeat Steps 5 and 6. If voltage increases replace regulator as described later in this section. If voltage does not increase generator is at fault.

GENERATOR REPLACEMENT

Due to variations in design and the equipment used, the replacement procedures will vary accordingly. The removal and installation instructions following are intended only as a guide. Additional operations may be required on some vehicles to remove additional equipment to gain access to generator, drive belt, and/or brackets.

GENERATOR REMOVAL

1. Disconnect negative battery cable from battery.

IMPORTANT: It is important that battery negative terminal be disconnected since generator will be damaged if wiring or terminals are accidentally shorted or grounded while being disconnected.

2. Remove shield from generator drive pulley.
3. Remove nuts and washers from harness leads at generator terminals. Tag each wire to aid in identification, then remove leads from terminals.
4. Loosen adjusting arm clamp bolt and generator to mounting bracket pivot bolts. Move generator to loosen the drive belt, then remove belt from generator pulley.
5. Remove adjusting arm clamp bolt and generator to mounting bracket bolts, then remove generator from vehicle.

GENERATOR INSTALLATION

IMPORTANT: Be sure negative battery cable is disconnected from battery. Failure to disconnect the battery cable may result in damage to the generator.

1. Position generator on mounting bracket and install generator to mounting bracket bolts and adjusting arm to generator clamp bolt and washers.
2. Place drive belt over generator drive pulley and adjust belt tension as explained previously. Tighten mounting bracket pivot bolts and adjustment arm clamp bolt to torque recommended in "Specifications" at end of this section.

3. Connect harness leads to respective terminals on generator. Install attaching nuts and washers.

4. Install protective shield over generator drive pulley if removed.

5. Connect negative battery cable to battery, then perform "Generator Output Test" described previously to determine if generator is operating within specified limits.

GENERATOR BENCH TEST

DIODE (RECTIFIER) TEST

NOTE: When checking each diode (rectifier cell) push and pull slightly on the lead to check for loose connections. If an ohmmeter is used, select an ohmmeter having a 1½ volt cell and a scale on which the 300 ohm value can be easily read.

IMPORTANT: Do not use high voltage such as a 110-volt test lamp to test rectifiers.

1. Remove two bolts which attach cover to slip ring end frame, then remove cover (fig. 11).

2. Remove internal (G+) terminal stud nut and washer from back of generator (fig. 10), then remove three diode leads and the (G+) jumper lead. Connect these four leads together with a bolt. Repeat this operation with the internal (G-) leads (fig. 10). Again bolt all four leads together.

NOTE: All external leads from (G+). (G-) and (AC) terminals must be disconnected.

3. With either lead of a 12-volt test light or ohmmeter attached to the external (G+) terminal stud, place remaining test lead on the external (AC) terminal studs, one at a time. Repeat this test with leads reversed. Continuity should be present in only one direction.

4. Repeat the above test for (G-) terminal. Again reverse test lead connections. Continuity should be present in only one direction.

5. The absence of continuity in either direction indicates an open diode.

6. Continuity in both directions indicates a shorted diode.

7. If a diode is faulty, it will be necessary to remove and disassemble generator for replacement.

NOTE: When checking diodes with an ohmmeter, a good diode will give one low and one high reading.

ROTOR COIL TEST

1. Remove two bolts which attach cover to slip ring end frame, then remove the cover (fig. 11).

2. Referring to figure 11, remove nuts, washers, and leads from (F+) and (F-) brush terminals. Remove two brush holders and slip ring brushes with springs.

3. To check for ground, place one ohmmeter or test lamp prod on case and the other test lead through brush holder opening on slip ring. If ohmmeter reading is high or if test lamp lights, the rotor coil is open.

4. To check for an open circuit, insert ohmmeter test prods into brush holder openings and make direct contact with each of the two slip rings. If ohmmeter reading is very low or if test lamp does not light, rotor coil circuit is open.

5. The rotor coil may be tested for a short with an ohmmeter or ammeter as follows:

<u>Ohmmeter Method</u>: Set ohmmeter on direct scale and place prods directly on each slip ring. Ohmmeter should read between 4.9 and 5.3 ohms. If reading is below 4.9 ohms, the rotor coil is shorted.

<u>Ammeter Method</u>: Insert 12-volt battery and ammeter in series with (F+) lead wire and terminal (fig. 11). Ammeter should register 3 amps. If reading is above 3 amps the rotor coil is shorted.

NOTE: If brush springs were collapsed, the rotor may have shorted turns within the coil.

6. If rotor coil fails to pass previously mentioned tests, the generator must be disassembled for repair.

STATOR TEST

1. Remove two bolts which attach cover to slip ring end frame, then remove the cover (fig. 11).

2. Remove three nuts which attach stator leads to the insulator, then remove the leads.

3. Place one test prod of an ohmmeter or a 110-volt test lamp on ground and the other test prod on each of the stator leads. If ohmmeter reading is high or if test lamp lights, the stator is grounded.

4. Connect an ohmmeter between stator leads as shown in figure 12. Each phase should show a closed circuit or indicate a low resistance. If ohmmeter reading is high, stator windings are open.

5. To check the stator for a short requires special test equipment. If all other generator checks are satisfactory and generator fails to produce rated output, the stator is shorted and generator must be disassembled for repair.

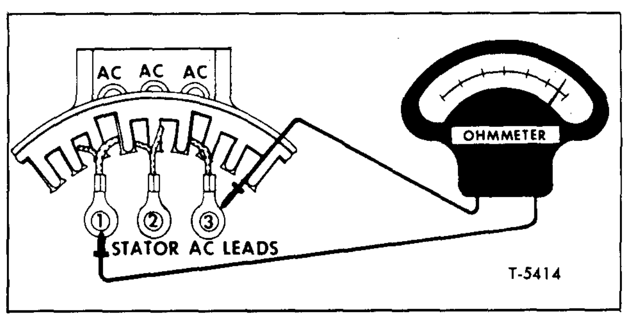


Figure 12—Stator Winding Continuity Test (Typical)

BRUSH REPLACEMENT

1. Loosen two attaching bolts, then remove slip ring end rectifier cover (fig. 11).

2. Remove wires from (F+) and (F–) terminals on brush holder studs (fig. 11).

3. Remove brush holders with brushes and springs. Replace brushes if shorter than 3/16-inch.

4. Connect wires to (F+) and (F–) terminals (fig. 11), then install slip ring end rectifier cover and attach with two bolts.

REGULATOR REPLACEMENT

1. Disconnect negative terminal at battery, or batteries.

2. Loosen two bolts and remove slip ring end rectifier cover (fig. 11).

3. Remove three AC leads from regulator at heat sink (larger white wires) (fig. 11).

4. Remove internal (G+) and (F–) nuts (fig. 10) at regulator terminal plate. Lift off three diode leads from each cap screw.

NOTE: The location of leads to assure the same positioning later.

5. Remove four round-head screws which retain regulator to housing. (Two are adjacent to power transistor while two additional ones are directly above and in line with previous two removed.) (Refer to fig. 10.)

6. Replace regulator assembly in reverse order of disassembly being careful that all insulating sleeves and washers are properly installed.

7. Check regulator voltage setting, then perform output test as directed previously

ADJUSTING VOLTAGE REGULATOR SETTING

1. Install voltmeter at battery.

2. The voltage adjustment screw is accessible through a hole in rectifier cover.

3. Run engine for approximately 15 minutes at 800 engine rpm to normalize electrical system.

4. Voltmeter should read 13.5 to 13.9. If necessary to adjust, turn voltage regulator adjusting screw (fig. 10) to set voltage within range. (Clockwise to increase, or counterclockwise to decrease.)

NOTE: Proper setting is obtained when battery remains fully charged with a minimum use of water.

If any circuit defects are found, yet the battery remains undercharged, raise the setting by 0.3 volt, then check the battery over a period of time to see if improvements were achieved; reset regulator if necessary. If the system is overcharging, lower the setting by 0.3 volt, then check battery over a period of time.

INTEGRAL TYPE ALTERNATING CURRENT GENERATING SYSTEM SPECIFICATIONS

GENERATOR MODEL	1117225 1117231	655988
Make	Delco-Remy	Leece Neville
Field Current at 80°F.		
Amps	4.1-4.5	3
Volts	12	12
Cold Output at Specified Volts		
Volts	14	14
Amps	22 (a)	36 (a)
Generator R.P.M. (Approx.)	1100	1100
Amps	65 (a)	97 (a)
Generator R.P.M. (Approx.)	2500	2500
Rated Hot Output (Amps.)	75	105

(a) If generator output is checked without a regulator, the output should be 5-10% higher than the value given.

ALTERNATING CURRENT GENERATOR TORQUE SPECIFICATIONS

	TORQUE (FT. LBS.)
Generator Bracket to Engine Bolts	
6-71 Engine	25-35
8V-71 Engine	50-60
Generator Mounting Bracket to Engine Bracket Pivot Bolt Nut	40-50
Generator to Adjusting Arm Bolt	55-65
Adjusting Arm to Engine Bolt	25-30
Pulley-to-Generator Nut	55-60

SECTION 7

TRANSMISSIONS AND CLUTCHES

This group is divided into six sections as shown in Index below:

TRANSMISSION CONTROL LINKAGE

Contents of this section are listed in Index below:

TILT CAB MODELS WITH MANUAL TRANSMISSION

LINKAGE ADJUSTMENT

SERIES 70-80

NOTE: Key numbers in text refer to figure 1.

1. Place transmission selector and shift levers (9) in "NEUTRAL" position.
2. Adjust selector and shift rods (8) to provide 90^{o} angularity at the lower end of the gearshift lever (1) to the control island panel (2) as shown.

NOTE: On Model TM80A with Clark 387V transmission the angularity between the gearshift lever (1) and control island panel (2) after adjustment should be 98^{o} 30'.

Adjustment is accomplished by rotating the adjustable clevis (see Inset, fig. 1) at either the control island or transmission end of the selector and shift rods (8). Tighten lock nuts securely.

3. Check adjustment by moving gearshift lever through the shift pattern. There must be no binding in the linkage.

NOTE: At the extreme selector and shift movements, clevis pins should rotate freely. Re-adjust linkage, if necessary, to obtain these conditions.

4. Replace any worn or damaged cotter pins.
5. Lubricate control linkage as described in LUBRICATION (SEC. 0) of this manual.

SERIES 90

One-Piece Shift Rod (Fig. 2)

1. Remove lock wire from universal joint set screw at both ends of the shift rod.
2. Loosen setscrew at each universal joint.
3. Locate the shift control rod on the remote control assembly (at the transmission) in neutral position.
4. With the gearshift lever held perpendicular (90^{o}) to the control island shift mechanism as shown by an assistant, adjust the position of both universal joints on the shift rod to retain the above mentioned conditions.

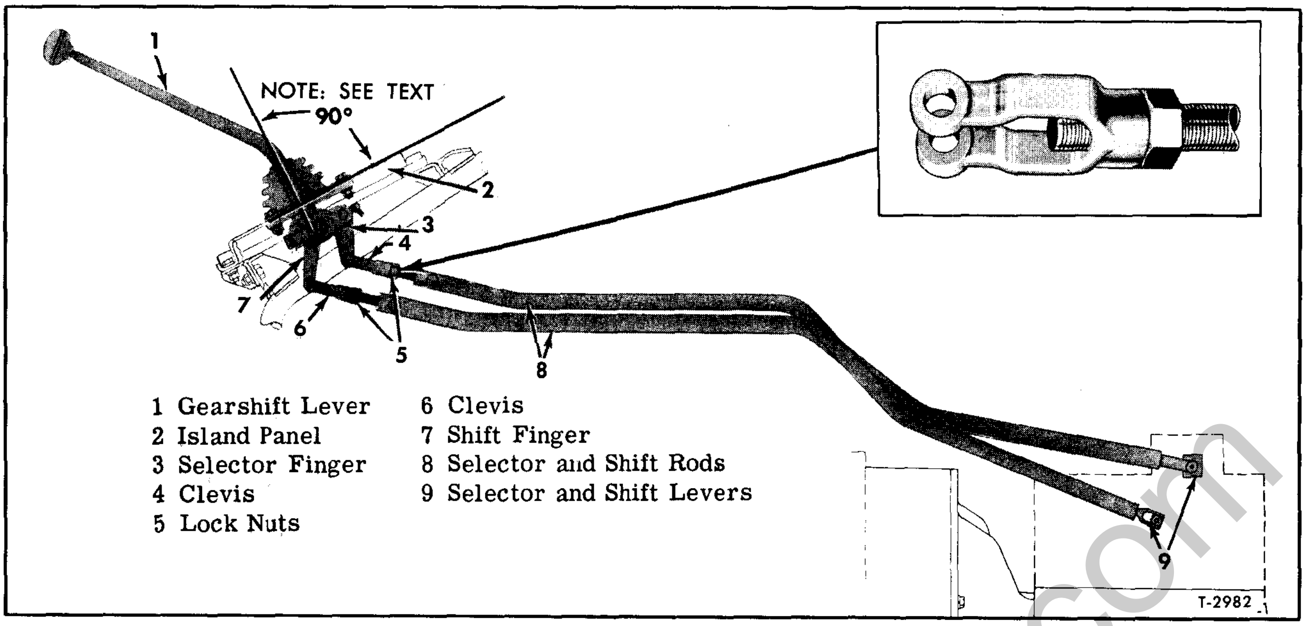


Figure 1—Tilt Cab Transmission Control Linkage (70-80 Series)

5. Tighten setscrews securely.

NOTE: Be sure setscrews are seated in the locating holes of the shift rod.

6. Check adjustment by moving gearshift lever through the shift pattern. There must be no binding in the linkage. Readjust linkage if necessary to obtain these conditions.

7. Using new lock wire, secure setscrew at each universal joint.

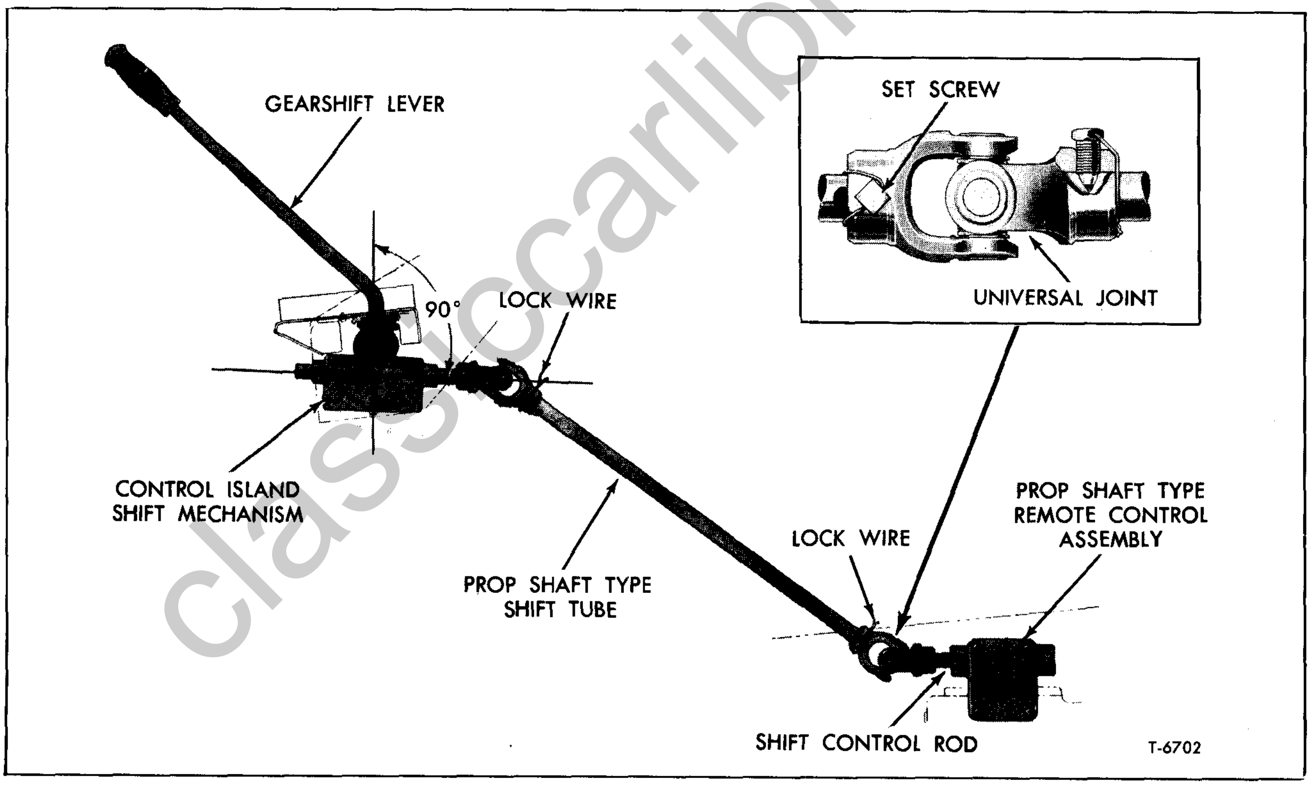


Figure 2—Tilt Cab with One-Piece Shift Rod (90 Series)

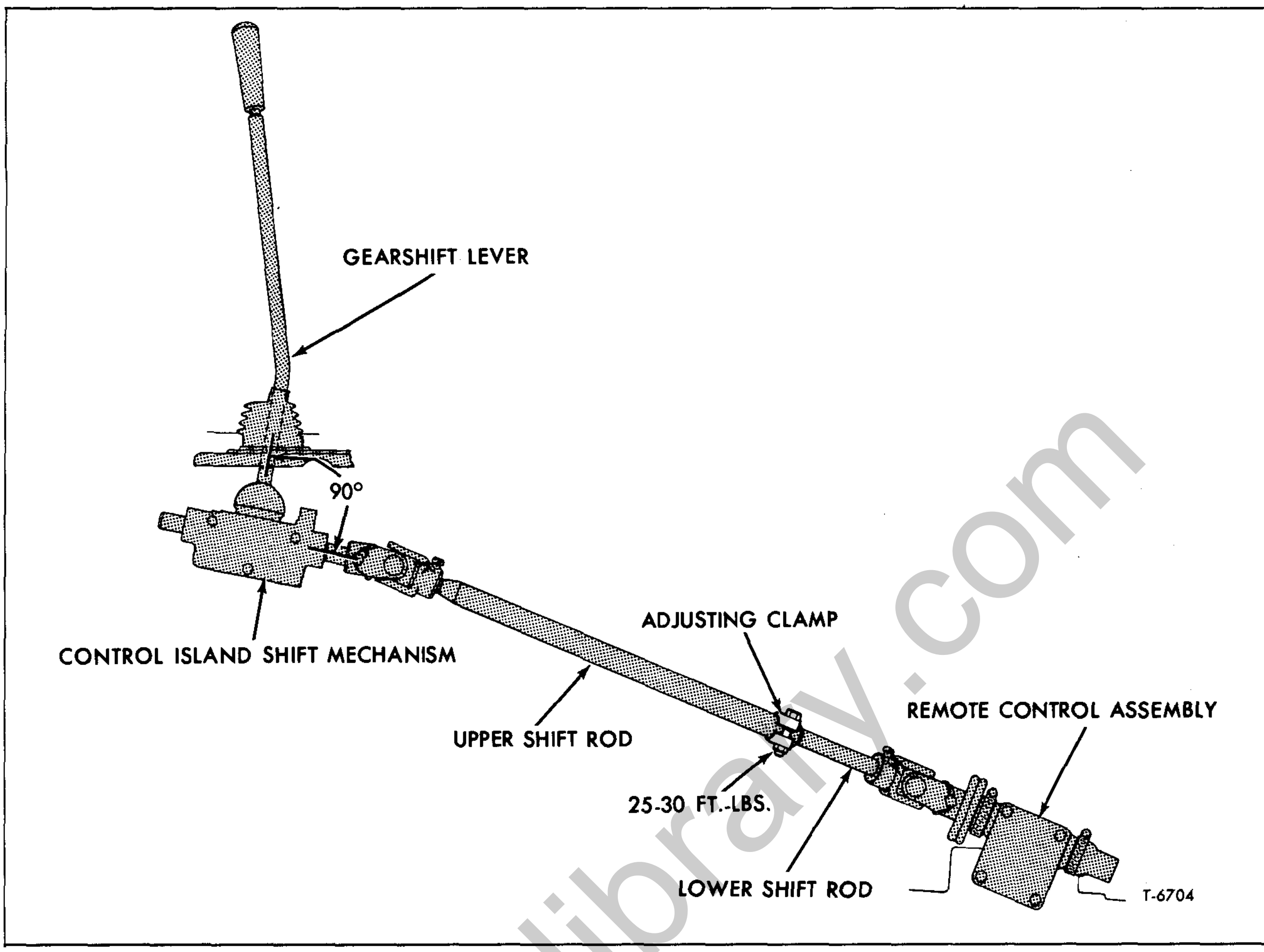


Figure 3—Tilt Cab with Two-Piece Shift Linkage (90 Series)

Two-Piece Shift Linkage (Fig. 3)

Perform the following steps with the cab tilted:

1. Loosen the adjustment clamp attaching parts.

2. Locate the lower shift rod on the remote control assembly (at the transmission) in neutral position.

3. With the gearshift lever held perpendicular (90^{o}) to the control island shift mechanism, secure the adjusting clamp in position as shown. Tighten adjusting clamp nut to 25-30 foot-pounds torque.

4. Check adjustment by moving gearshift lever through the shift pattern. There must be no binding in the linkage. Readjust linkage if necessary to obtain these conditions.

CONTROL ISLAND SHIFT MECHANISM

If shift controls at control island panel become worn or damaged, make repairs as described in the following text:

SERIES 7500 SHIFT MECHANISM

Removal

NOTE: Key numbers in text refer to figure 4.

1. At the control island panel, disconnect shift rod (6) from shift finger (10). Also, disconnect selector rod (7) from selector finger (9).

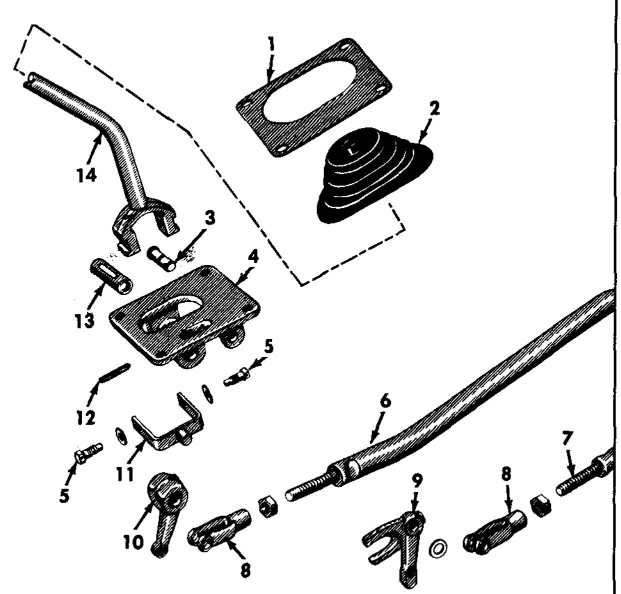
IMPORTANT: On tilt cab models equipped with a Fuller transmission, remove range control valve and air lines from the gearshift lever by first bleeding the air tanks. Then remove control valve and air lines from control island shift mechanism. Place protective plugs or tape over air valve and air line openings to prevent entry of dirt.

2. Remove the shift mechanism assembly-to-control island panel attaching parts and then remove assembly from vehicle.

3. Remove gearshift knob, boot retainer (1) and boot (2).

Disassembly

NOTE: Key numbers in text refer to figure 4.



1 Boot Retainer	9 Selector Finger
2 Boot	10 Shift Finger
3 Selector Finger Pin	11 Selector Finger Strap and Pin Assembly
4 Control Cover	12 Roll Pin
5 Pivot Screw	13 Pivot Pin
6 Shift Rod	14 Gearshift Lever
7 Selector Rod	
8 Adjustable Clevis	

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Figure 4—Typical Control Island Shift Mechanism (70-80 Series)

1. Remove cotter pin and washer from selector finger pin (3), then remove selector finger (9).
2. Remove lock wires from pivot screws (5), then remove pivot screws, washers and selector finger strap and pin assembly (11).
3. Remove gearshift lever (14).
4. Using hammer and punch, remove roll pin (12), pivot pin (13), and then remove shift finger (10) from control cover (4).

Cleaning and Inspection

1. Clean all parts thoroughly in cleaning solvent. Wipe or blow parts dry.
2. Check all parts for wear, distortion, cracks, or other damage.
3. Replace all parts that would affect proper selection of transmission gears.

Assembly

NOTE: Key numbers in text refer to figure 4.

1. Place gearshift lever on shift lever finger (10) and position in control cover. Install pivot pin (13) and roll pin (12).
2. Install selector finger strap and pin assembly (11), washers and two pivot screws (5). Torque screws to 60-65 foot-pounds and install new lock wires to pivot screws.
3. Install selector finger pin (3), selector finger (9), washer and new cotter pin.

Installation

NOTE: Key numbers in text refer to figure 4.

1. Install boot (2), boot retainer (1) and gearshift knob to shift mechanism assembly.
2. Place shift assembly in proper position on control island and install attaching parts.

IMPORTANT: On tilt cab models equipped with a Fuller transmission, position range control valve on gearshift lever at least 3 inches below the gearshift knob. Reconnect the air lines to the control valve and check the system for air leaks and proper operation upon completion of the following step:

3. Connect shift control linkage to selector finger (9) and shift finger (10), then adjust shift control linkage as covered previously under "Linkage Adjustment" procedures.

SERIES 90 - CONTROL ISLAND SHIFT MECHANISM

Removal

NOTE: Key numbers in text refer to figure 5.

1. Remove lock wire and setscrew (15) attaching universal joint assembly to shift rod.
2. Remove gearshift lever grip (28).

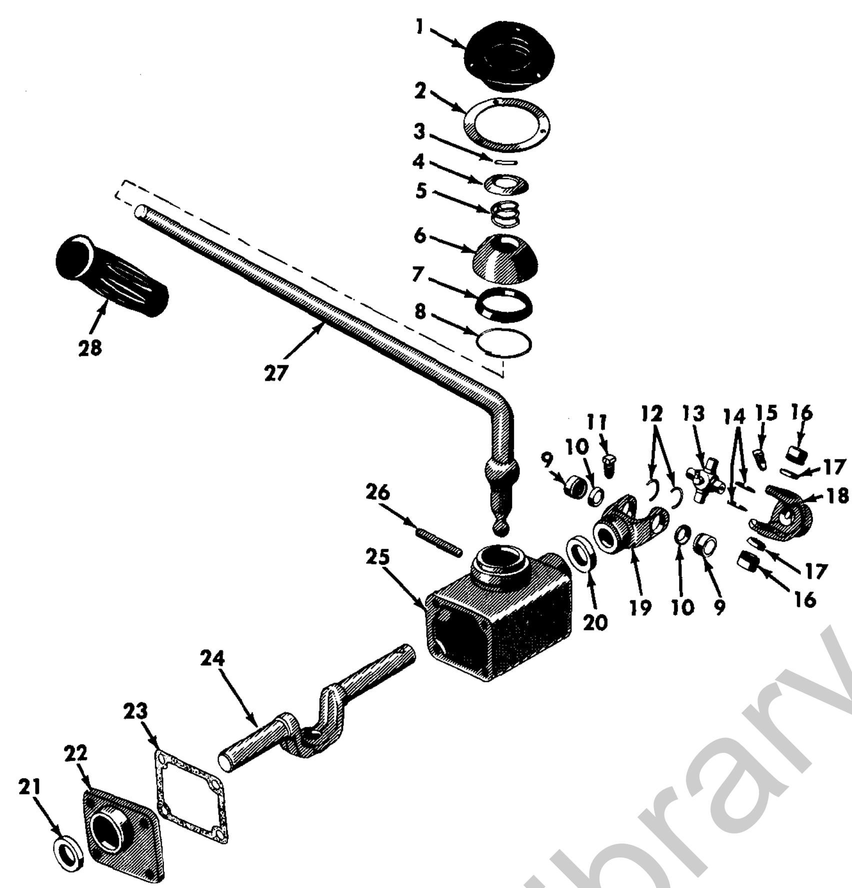
IMPORTANT: On vehicles equipped with a Fuller transmission, remove range control valve and air lines from the gearshift lever by first bleeding the air tanks. Then remove the control valve and air lines from control island shift mechanism. Place protective plugs or tape over valve and air line openings to prevent entry of dirt.

3. Remove screws attaching boot (1) and retainer (2) to control island. Remove boot and retainer.
4. Remove attaching parts that retain the prop shaft type shift mechanism to the control island support assembly.
5. Remove shift mechanism and gearshift lever from the vehicle and mount in a soft-jawed vice.

Disassembly

NOTE: Key numbers in text refer to figure 5.

1. Press down on compression collar (4), then using a hammer and punch, drive collar pin (3) out of shift lever (27).
2. Slide compression collar (4), spring (5) compression cup (6), and washer (7) up off gearshift lever.
3. Remove snap ring (8), rock shaft (26), and gearshift lever (27) from housing (25).
4. Remove lock wire, setscrew (11) and remove universal joint assembly from shift rod (24).
5. Remove attaching parts from housing end



1 Boot
2 Boot Retainer
3 Collar Pin
4 Compression Collar
5 Spring
6 Compression Cup
7 Compression Washer
8 Snap Ring
9 Bearings
10 Washers
11 Set Screw
12 Snap Rings
13 Journal Cross
14 Snap Rings
15 Set Screw
16 Bearings
17 Washers
18 End Yoke
19 End Yoke
20 Oil Seal
21 Oil Seal
22 Housing end Cover
23 Gasket
24 Shift Rod
25 Remote Control Housing
26 Rock Shaft
27 Gearshift Lever
28 Gearshift Lever Grip

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Figure 5—Typical Control Island Shift Mechanism (90 Series)

cover (22); then remove end cover and gasket (23) from housing (25). Discard gasket.

6. Remove shift rod (24) from housing (25).

7. Remove two snap rings (12); then tap one side of end yoke (19) to force bearing (9) and washer (10) out of yoke. Strike opposite side of yoke to force out opposite bearing and washer.

8. Remove the other two bearings (16) and washers (17) in the same manner.

9. Separate end yokes (18 and 19) from journal cross (13).

Cleaning and Inspection

NOTE: Key numbers in text refer to figure 5.

1. Clean all parts thoroughly with suitable cleaning solvent. Wipe or blow parts dry.

2. Examine all parts for scoring, cracks, or other damage. Discard all parts that are not in good condition.

3. If inspection shows oil seals (20 and 21) to be worn or deteriorated, drive oil seals out of cover and housing. Using a suitable sleeve, press or drive new oil seals into bores of end cover and housing.

Assembly

NOTE: Key numbers in text refer to figure 5.

1. Position shift rod (24) in housing (25); then install end cover (22) and new gasket (23) on housing (25). Tighten attaching bolts firmly.

2. Position journal cross (13) in end yoke (19). Install washers (10) and bearings (9) on journal cross (13) and retain parts with snap rings (12).

3. Install the other washers (17), bearings (16) and snap rings (14) in the same manner.

4. Install universal joint assembly on shift rod (24) and secure with setscrew (11). Tighten setscrew firmly and retain with new lock wire.

5. Fill control housing ¾ full with chassis lubricant.

6. Insert gearshift lever (27) through top of housing (25). Install rock shaft (26) and snap ring (8).

7. Position compression washer (7), cup (6), spring (5), and collar (4) over gearshift lever (27). Press down on compression collar (4) and install collar pin in gearshift lever. Check for free movement in shift mechanism.

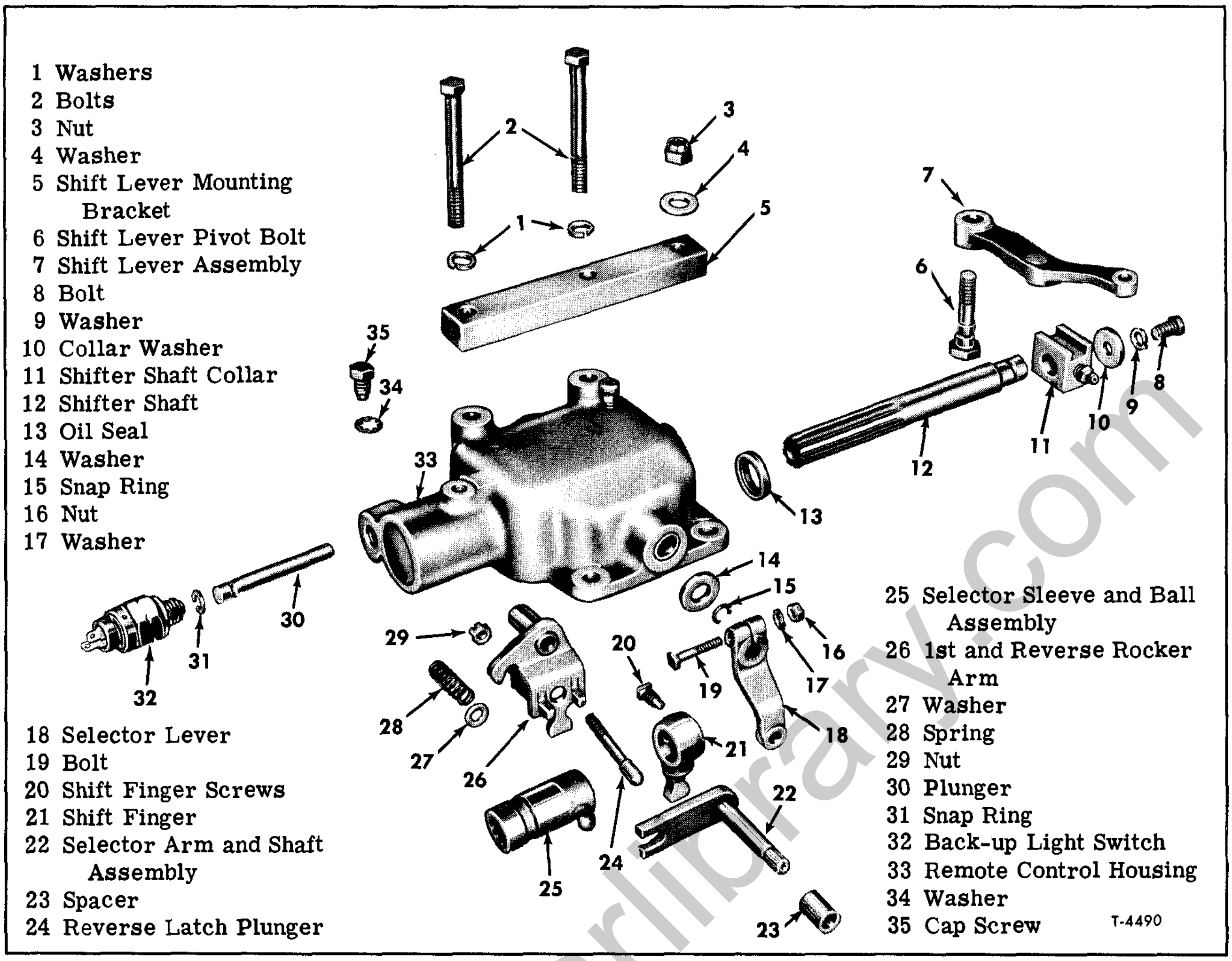


Figure 6—Clark 282V and 285V Remote Control Assembly

Installation

NOTE: Key numbers in text refer to figure 5.

1. Install boot (1) and retainer (2) on control island. Tighten screws firmly.
2. Install prop shaft type shift mechanism and support assembly in the vehicle. Tighten attaching parts firmly.
3. Position universal joint assembly on prop shaft type shift rod. Install setscrew (15) and tighten firmly.
4. Install gearshift lever grip (28).

IMPORTANT: On vehicles equipped with a Fuller transmission, position range control valve on gearshift lever three inches below the bottom of the gearshift lever grip. Reconnect the air lines to the control valve and check the system for air leaks and proper operation upon completion of the following step:

5. Adjust transmission shift control linkage as described previously under "Linkage Adjustment."

REMOTE CONTROL ASSEMBLY (AT TRANSMISSION)

Tilt cab vehicles have transmission remote control assemblies as shown in figures 6, 8, 10, and 12. Should parts become worn or defective, make repairs as described in the following text:

CLARK 282V AND 285V REMOTE CONTROL ASSEMBLY

Removal

1. Position transmission gearshift lever in "NEUTRAL" and disconnect shift control rods from shift levers at transmission.
2. Disconnect electrical connector from back-up light switch.
3. Remove remote control assembly-to-transmission attaching parts, then remove assembly from vehicle.

4. Place a clean shop towel over transmission opening to prevent entry of dirt or other foreign material.

Disassembly

NOTE: Key numbers in text refer to figure 6.

1. Remove lock wire and shift finger screw (20), then remove shifter shaft (12) and shift finger (21) from remote control housing (33).
2. Remove attaching parts holding shifter shaft collar (11) to shifter shaft (12), then remove shifter shaft collar.
3. Remove 1st and reverse rocker arm (26) from housing. Remove cotter pin from nut (29), then remove nut (29) from reverse latch plunger (24) releasing spring (28), washer (27) and plunger (24).
4. Loosen nut (16) and remove selector lever (18).
5. Remove snap ring (15) and washer (14) from selector arm and shaft assembly (22).
6. Remove cap screw (35) and washer (34) from housing.
7. Rotate selector sleeve and ball assembly (25) away from selector arm and shaft assembly (22), then remove selector sleeve and ball assembly from housing.
8. Remove selector arm and shaft assembly (22) and spacer (23) from housing.
9. Remove attaching parts that retain shift lever assembly (7) to shift lever mounting bracket (5), then remove shift lever assembly.
10. Remove attaching parts that retain shift lever mounting bracket (5) to housing, then remove shift lever mounting bracket.

Cleaning and Inspection

1. Clean all metal parts thoroughly in cleaning solvent.
2. Check all parts for wear, distortion, cracks or other damage.
3. Replace all parts that would affect proper selection of transmission gears.

Oil Seal Replacement

1. Press or pry oil seals out of remote control housing.
2. Using a suitable sleeve, press or drive new oil seal into bore of housing.

NOTE: Coat outer diameter of oil seal with a light coat of sealing cement prior to installation.

Assembly

NOTE: Key numbers in text refer to figure 6.

1. Position selector sleeve and ball assembly (25) in remote control housing (33), then install washer (34) and cap screw (35). Tighten screw firmly.

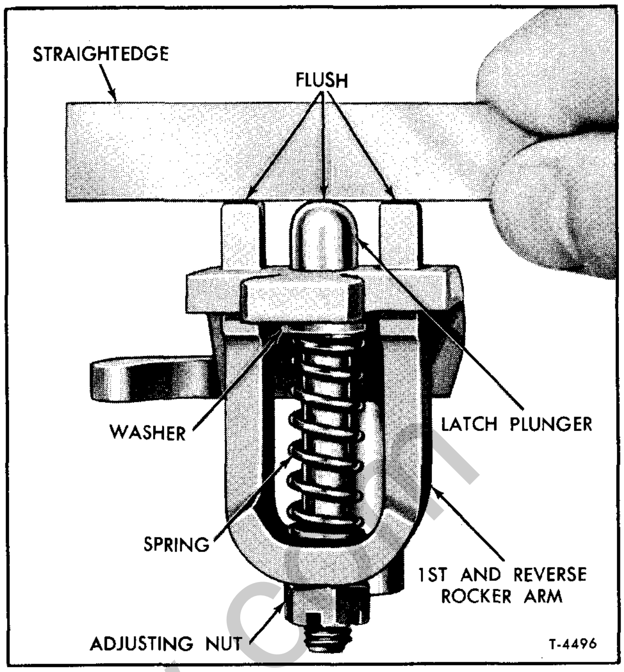


Figure 7—Reverse Latch Plunger Adjustment

2. Position selector arm and shaft assembly (22) and spacer (23) in housing, then install washer (14) and snap ring (15).
3. Assemble reverse latch plunger (24), washer (27), spring (28), and nut (29) to 1st and reverse rocker arm (26).
4. Adjust reverse latch plunger so rounded end is flush or slightly below the two flat ends of the 1st and reverse rocker arm as shown in figure 7. Secure adjusting nut in proper position with a cotter pin. Install reverse latch plunger assembly in housing.
5. Position shift finger (21) in housing (33); then install shifter shaft (12) in housing, aligning splines of shifter shaft with splines of selector sleeve and ball assembly (25), and hole in shifter shaft with hole in shift finger (21).
6. Install shift finger screw (20). Tighten screw to 25 foot-pounds torque and secure with lock wire.
7. Install attaching parts that retain shifter shaft collar (11) to shifter shaft (12).
8. Install attaching parts that hold shift lever assembly (7) to shift lever mounting bracket (5). Tighten nut to 25-31 foot-pounds torque.
9. Install attaching parts that hold shift lever mounting bracket (5) to housing (33). Be sure shift lever assembly (7) is properly seated in slot of shifter shaft collar (11).
10. Position selector lever (18) on selector arm and shaft assembly (22), so that the selector lever is perpendicular to the gasket side of the housing (33). Tighten nut (16) firmly.

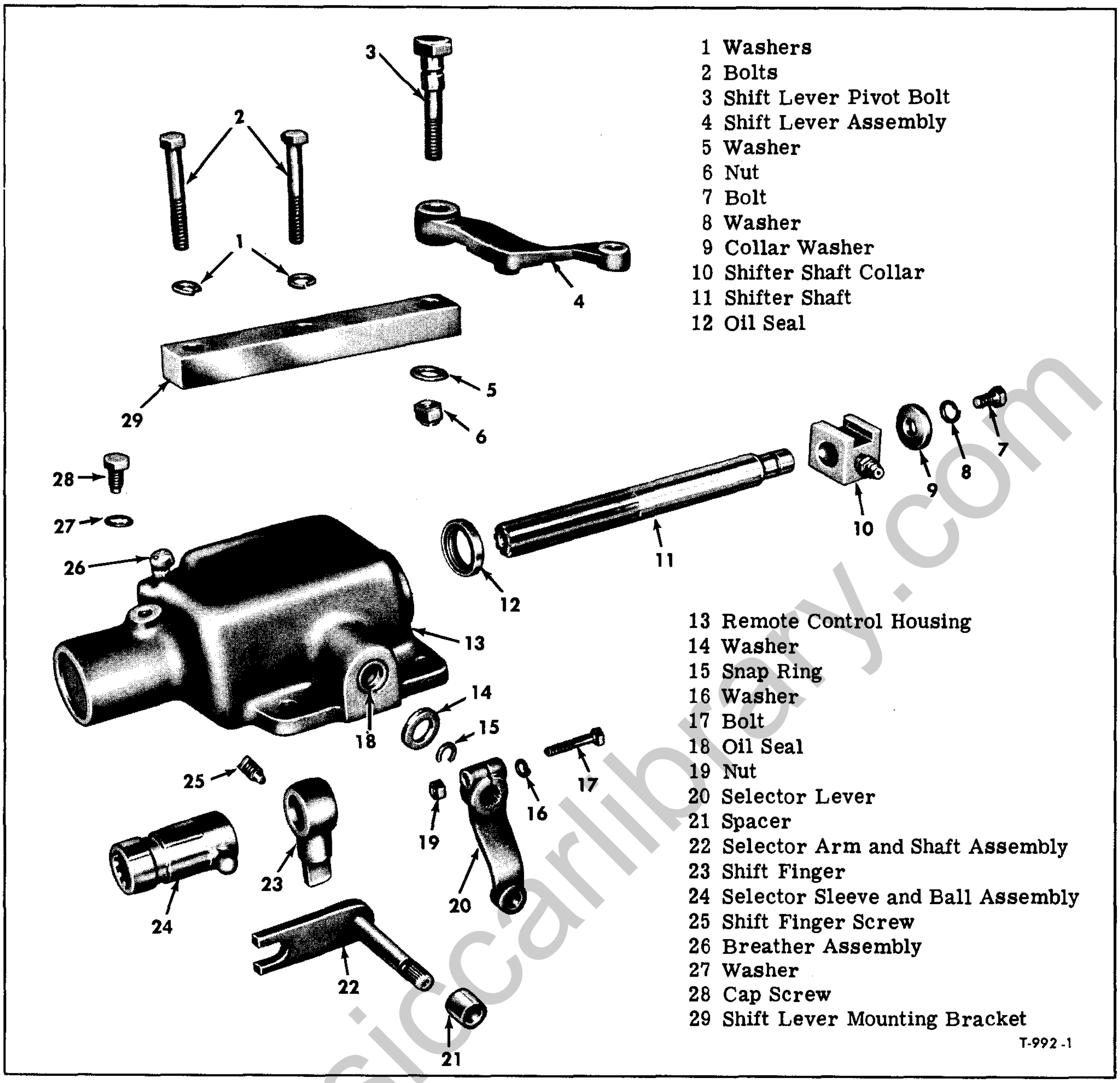


Figure 8—Clark 387V Remote Control Assembly

Installation

1. Position a new gasket on transmission.
2. With all parts in "NEUTRAL" position, carefully place remote control assembly on transmission cover.
3. Install remote control assembly-to-transmission cover attaching parts. Tighten the bolts firmly.
4. Connect shift control rods to remote control assembly.
5. Adjust transmission control linkage as described previously under "Linkage Adjustment."

CLARK 387V REMOTE CONTROL ASSEMBLY

Removal

1. Position transmission gearshift lever in "NEUTRAL" and disconnect shift control rods from shift levers at transmission.
2. Remove remote control assembly-to-transmission attaching parts, then remove assembly from vehicle.
3. Place a clean shop towel over transmission opening to prevent entry of dirt or other foreign material.

Disassembly

NOTE: Key numbers in text refer to figure 8.

1. Remove lock wire and shift finger screw (25), then remove shifter shaft (11) and shift finger (23) from remote control housing (13).
2. Remove attaching parts holding shifter shaft collar (10) to shifter shaft (11), then remove shifter shaft collar.
3. Loosen nut (19) and remove selector lever (20).
4. Remove snap ring (15) and washer (14) from selector arm and shaft assembly (22).
5. Remove cap screw (28) and washer (27) from housing.
6. Rotate selector sleeve and ball assembly (24) away from selector arm and shaft assembly (22), then remove selector sleeve and ball assembly from housing.
7. Remove selector arm and shaft assembly (22) and spacer (21) from housing.
8. Remove attaching parts that retain shift lever assembly (4) to shift lever mounting bracket (29), then remove shift lever assembly.
9. Remove attaching parts that retain shift lever mounting bracket (29) to housing, then remove shift lever mounting bracket.

Cleaning and Inspection

1. Clean all metal parts thoroughly in cleaning solvent. Wipe or blow parts dry.
2. Check all parts for wear, distortion, cracks or other damage.
3. Replace all parts that would affect proper selection of transmission gears.

Oil Seal Replacement

1. Press or pry oil seals (12 and 18, fig. 8) out of remote control housing.
2. Using a suitable sleeve, press or drive new oil seal into bore of housing.

NOTE: Coat outer diameter of oil seal with a light coat of sealing cement prior to installation.

Assembly

NOTE: Key numbers in text refer to figure 8.

1. Position selector sleeve and ball assembly (24) in remote control housing (13), then install washer (27) and cap screw (28). Tighten screw firmly.
2. Position selector arm and shaft assembly (22) and spacer (14) in housing, then install washer (14) and snap ring (15).
3. Position shift finger (23) in housing (13); then install shifter shaft (11) in housing, aligning splines of shifter shaft with splines of selector sleeve and ball assembly (24), and hole in shifter shaft with hole in shift finger (23).
4. Install shift finger screw (25). Tighten screw to 25 foot-pounds torque and secure with lock wire.
5. Install attaching parts that retain shifter shaft collar (10) to shifter shaft (11).
6. Install attaching parts that hold shift lever assembly (4) to shift lever mounting bracket (29). Tighten nut to 25-31 foot-pounds torque.
7. Install attaching parts that hold shift lever mounting bracket (29) to remote control housing (13). Be sure shift lever assembly (4) is properly seated in the slot of shifter shaft collar (10).
8. Position selector lever (20) on selector arm and shaft assembly (22), so that the selector lever is perpendicular to the gasket side of the housing (13). Tighten nut (19) firmly.

Installation

1. Position a new gasket on transmission cover.
2. With all parts in "NEUTRAL" position, carefully place remote control assembly on transmission cover.
3. Install remote control assembly-to-transmission cover attaching parts. Tighten bolts firmly.
4. Connect shift control rods to remote control assembly.
5. Adjust transmission control linkage as described previously under "Linkage Adjustment."

ROD TYPE REMOTE CONTROL ASSEMBLY

NOTE: The rod-type remote control assembly shown in figure 10 is found on various Spicer transmissions. The procedures are the same for both, except as noted:

Removal

1. Position transmission gearshift lever in neutral and disconnect the shift control rods from the shift levers at transmission.

IMPORTANT: On all Spicer transmissions, remove the retainer, plunger pin spring, and plunger pin shown in figure 9. Keep the remote control assembly slightly tilted to the left, as shown, to prevent the plunger from falling into the transmission during removal.

2. Remove remote control assembly-to-transmission attaching parts, then carefully remove assembly and gasket from vehicle.
3. Place a clean lint-free cloth over the transmission opening to prevent entry of dirt or other foreign material.

Disassembly

NOTE: Key numbers in text refer to figure 10.

1. Mark location of shift lever (16) in relation to shift finger shaft (15) to facilitate assembly. Loosen clamp bolt on shift lever, then remove shift lever and thrust washer (14).
2. Remove selection lever (11) from selection cam and stud assembly (6).

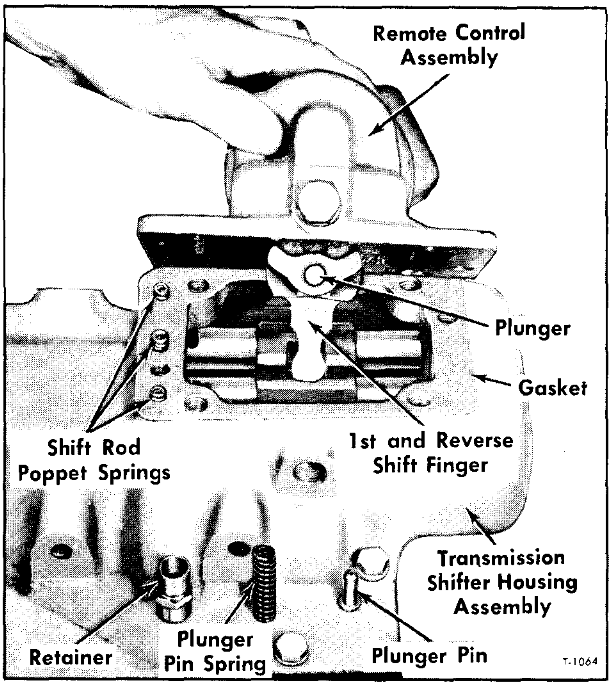
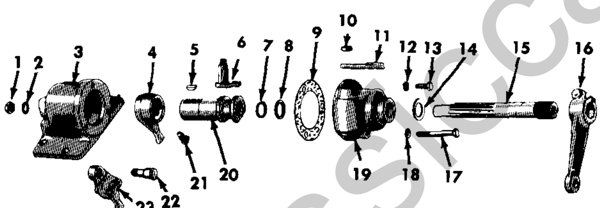


Figure 9—Removing Rod Type Remote Control Housing

3. Through opening in bottom of control housing (3), remove lock wire and shift finger screw (21) from shift finger (4).
4. Remove attaching parts that hold end cover (19) to control housing (3).
5. Remove shift finger shaft (15) and end cover (19) from control housing (3). Remove shift finger (4) from control housing.
6. Rotate the selection lever shaft (20) 180 degrees, then remove selection lever shaft from shift finger shaft (15).
7. Remove shift finger shaft (15) and selection cam and stud assembly (6) from end cover (19).
8. On all Spicer transmissions, remove attaching parts holding reverse shift finger (23) to control housing (3), then remove reverse shift finger.



1 Nut	13 Bolt
2 Lock Washer	14 Thrust Washer
3 Control Housing	15 Shift Finger Shaft
4 Shift Finger	16 Shift Lever
5 Shift Finger Key	17 Bolt
6 Selection Cam and Stud Assembly	18 Washer
7 Snap Ring	19 End Cover
8 Thrust Washer	20 Selection Lever Shaft
9 Gasket	21 Shift Finger Screw
10 Nut	22 Reverse Shift Finger Stud
11 Selection Lever	23 Reverse Shift Finger
12 Washer	

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Figure 10—Rod Type Remote Control Assembly

Cleaning and Inspection

1. Clean all parts thoroughly with suitable cleaning solvent. Wipe or blow parts dry.
2. Examine all parts for scoring, cracks, or other damage. Discard all parts that are not in good condition.

Assembly

NOTE: Key numbers in text refer to figure 10.

1. On all Spicer transmissions, install reverse shift (23) in control housing (3). Tighten attaching nut firmly.
2. Install selection cam and stud assembly (6) into end cover (19).
3. Install snap ring (7) and thrust washer (8) on shift finger shaft into end cover.
4. Install shift finger key (5) on selection lever shaft (20).
5. Slide selection lever shaft (20) onto shift finger shaft (15). Rotate selection lever shaft until selection cam and stud assembly (6) properly engages selection lever shaft. Then rotate selection lever shaft 180 degrees so that the shift finger key (5) is pointing upward as shown.
6. Position gasket (9) on control housing (3).
7. Position shift finger (4) in control housing (3), then while inserting the end cover (19) with shafts into control housing, install shift finger (4) on selection lever shaft (20).

NOTE: Be sure the shift finger (4) is installed on the shaft with the longer boss facing the end cover as shown.

8. Install end cover (19) to control housing (3). Tighten attaching bolts firmly.
9. Install shift finger screw (21) and new lock wire to shift finger (4).
10. Position selection lever (11) on selection cam and stud assembly (6), so that selection lever is parallel to the shift finger shaft (15). Tighten attaching nut firmly.
11. Align marks on shift lever (16) and shift finger shaft (15). If not previously marked position shift lever on shift finger shaft, so that angle "A" shown in figure 11 is as follows:

Transmission Model	Angle "A"
Spicer 5752C (When Used on TV70) . . .	37^{o}
All Other Spicer Transmissions	15^{o}

Tighten clamp nut firmly.

Installation

1. Position a new gasket on transmission cover.

> **CAUTION: On vehicles equipped with Spicer transmissions, keep the remote control assembly slightly tilted to the left during installation as shown in figure 9, to prevent the plunger from falling into the transmission.**

2. With all parts in "NEUTRAL" position, carefully place the remote control assembly on the transmission cover.
3. Install remote control assembly-to-transmission attaching parts. Tighten bolts securely.
4. Reconnect shift control rods to the shift levers on the transmission remote control assembly
5. Adjust transmission shift control linkage as described previously under "Linkage Adjustment."

PROP SHAFT TYPE REMOTE CONTROL ASSEMBLY (USED ON TILT CAB SERIES 90)

NOTE: The prop shaft type remote control assembly shown in figure 12 is found on various Clark, Fuller and Spicer transmissions. The procedures are the same for all transmissions, except as noted:

Removal

1. Remove lock wire and setscrew attaching universal joint assembly to prop shaft type shift rod shown in figure 2.

IMPORTANT: On vehicles equipped with Spicer 6000 Series transmissions remove the retainer, plunger pin spring and plunger pin shown in figure 9. Keep the remote control assembly slightly tilted to the left, as shown, to prevent plunger from falling into the transmission.

2. Remove remote control assembly-to-transmission attaching parts, then carefully remove assembly from vehicle.

NOTE: On vehicles equipped with Fuller transmissions, remove adapter plate which is mounted between remote control assembly and transmission shifter housing. On vehicles equipped with Clark transmissions, remove spacer and two gaskets. On all remaining transmission models, simply remove the gasket mounted between remote control assembly and transmission cover.

3. Place a clean lint-free cloth over the transmission opening to prevent the entry of dirt or other foreign material.

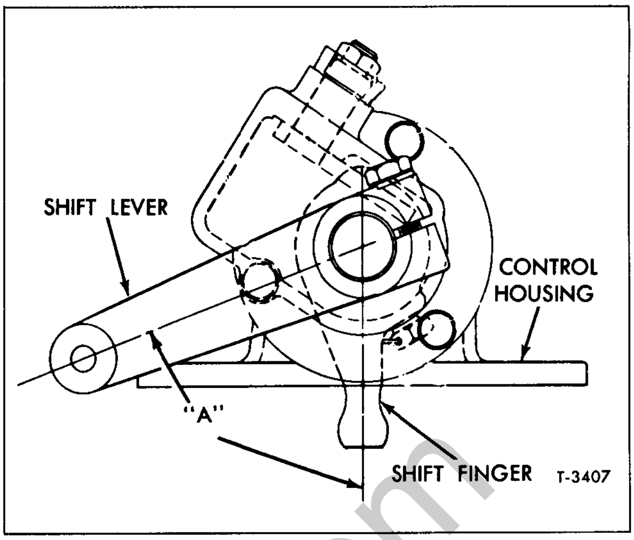
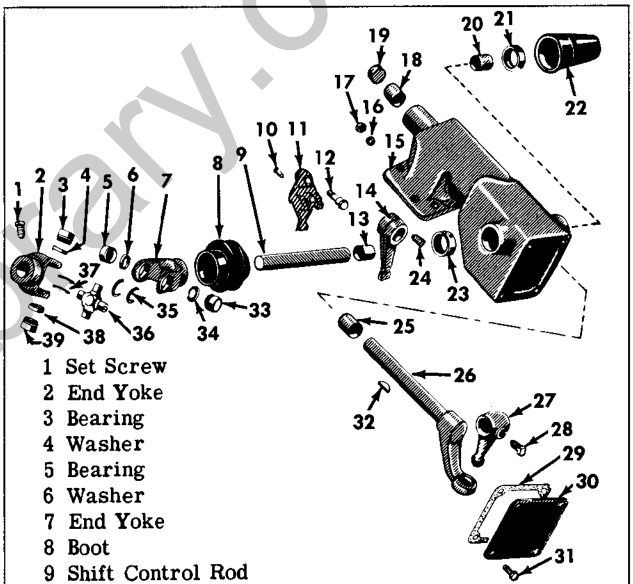


Figure 11—Rod Type Remote Control Assembly Adjustment



1 Set Screw
2 End Yoke
3 Bearing
4 Washer
5 Bearing
6 Washer
7 End Yoke
8 Boot
9 Shift Control Rod
10 Plunger
11 1st and Reverse Shift Finger
12 Shift Finger Stud
13 Bushing
14 Shift Finger (Inner)
15 Housing
16 Washer
17 Nut
18 Bushing
19 Plug
20 Bushing
21 Oil Seal
22 Boot
23 Oil Seal
24 Set Screw
25 Bushing
26 Shift Finger Shaft
27 Shift Finger (Outer)
28 Set Screw
29 Gasket
30 End Cover
31 Cap Screw
32 Woodruff Key
33 Bearing
34 Washer
35 Snap Rings
36 Journal Cross
37 Snap Rings
38 Washer
39 Bearing

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Figure 12—Prop Shaft Type Remote Control Assembly

Disassembly

NOTE: Key numbers in text refer to figure 12.

1. Remove lock wire and setscrew from end yoke (7). Remove universal joint assembly from shift control rod (9).
2. Remove two snap rings (37); then tap one side of end yoke (2) to force bearing (3) and washer (4) out end yoke. Strike opposite side of yoke to force out opposite bearing (39) and washer (38).
3. Remove the other two bearings (5 and 33) and washers (6 and 34) in the same manner.
4. Separate end yokes (2 and 7) from journal cross (36).
5. Remove boots (8 and 17).
6. Remove parts retaining end cover (30) and gasket (29) to the housing (15). Discard gasket.
7. Remove lock wire and setscrew (28) from outer shift finger (27); then remove shift control rod (9) and outer shift finger.

NOTE: On vehicles equipped with Spicer 6000 Series transmissions, hold shift finger stud (12) and remove nut (17) and washer (16). Remove 1st and reverse shift finger (11) from housing.

8. Remove lock wire and setscrew (24) from inner shift finger (14). Remove shift finger shaft (26) and inner shift finger from housing. Remove Woodruff key (32) from shift finger shaft.
9. Remove and discard oil seals (21 and 23).

Cleaning and Inspection (Fig. 12)

1. Clean all parts thoroughly with cleaning solvent. Wipe or blow parts dry.

NOTE: The housing (15) on some models, is equipped with a breather. Be sure it is clean.

2. Examine all parts for scoring, cracks, or other damage. Discard all parts that are not in good condition.
3. Carefully inspect bushings (13, 18, 20, and 25) for pitting, scoring or other damage. Replace as necessary.

Assembly

NOTE: Key numbers in text refer to figure 12.

1. Install new oil seals (21 and 23) in housing (15).
2. Install Woodruff key (32) on shift finger shaft (26).
3. While holding inner shift finger (14) in place in housing, insert shift finger shaft (26) into housing and through inner shift finger. Install setscrew (24) in inner shift finger.

IMPORTANT: Be sure setscrew is seated in the shift finger shaft. Tighten setscrew firmly and secure with new lock wire.

NOTE: On vehicles equipped with Spicer 6000 Series transmissions, insert shift finger stud (12) in 1st and reverse shift finger (11). Position in housing and install washer (16) and nut (17).

4. Position the outer shift finger (27) in the housing. Insert the shift control rod (9) into housing and through outer shift finger. Install setscrew (28) in outer shift finger.

IMPORTANT: Be sure setscrew is seated in the locating hole of the shift control rod. Tighten setscrew firmly and secure with new lock wire.

5. Fill that portion of the housing, which contains the outer shift finger ¾ full with chassis lubricant. Install new gasket (29) and end cover (30). Tighten cap screws securely.
6. Install boots (8 and 22) on each end of the shift control rod (9).
7. Position journal cross (36) in end yoke (2). Install washers (4 and 38) and bearings (3 and 39) on journal cross and secure with snap rings (37).
8. Install the remaining end yoke (7), washers (6 and 34), bearings (5 and 33), and snap rings (35) in the same manner.
9. Install universal joint assembly on shift control rod (9) and secure with setscrew on end yoke. Tighten setscrew firmly and secure with new lock wire.

Installation

NOTE: On vehicles equipped with Clark transmissions, position spacer and two gaskets on the opening. On remaining transmission models position gasket over transmission opening.

IMPORTANT: On vehicles equipped with Spicer 6000 Series transmissions, keep the assembly slightly tilted to the left during installation as shown in figure 9 to prevent the plunger from falling into the transmission. After the remote control assembly is seated on the transmission shifter housing install the plunger pin, plunger pin spring and retainer.

1. Position prop shaft type remote control assembly on transmission as shown in figure 2. Install the remote control assembly-to-transmission attaching parts. Tighten bolts firmly.
2. With the prop shaft type shift rod inserted in the universal joint assembly, tighten the setscrew firmly.
3. Adjust transmission control linkage as described previously under "Linkage Adjustment."

TRUCK MODELS WITH ALLISON AUTOMATIC TRANSMISSION

LINKAGE ADJUSTMENTS

Prior to making any checks or adjustments of transmission manual and throttle control linkage, check performance of the engine. The transmission is often blamed for poor operation of the vehicle when the engine is not tuned to deliver peak power. Refer to GASOLINE ENGINES (SEC. 6A) of this manual for recommended tune-up procedures. It should be kept in mind, that to assure efficient performance of power plant, the transmission should be as carefully balanced with the engine as are fuel and ignition systems.

The Allison transmission control linkage must be checked and properly adjusted whenever any of the following events occur:

1. At time of "New Vehicle Inspection," after final engine idle adjustments have been made.
2. After any transmission control linkage has been removed or replaced.
3. After transmission has been removed and reinstalled in vehicle.
4. When transmission is not performing properly.

ACCELERATOR AND TV LINKAGE ADJUSTMENTS

> **WARNING: DO NOT start engine with shift linkage disconnected, as serious injury could result to vehicle or personnel.**

The throttle linkage to transmission must be properly adjusted so that engine and transmission, as a matched pair, can give maximum performance. If transmission throttle linkage is incorrectly adjusted, the engine may not operate at full governed rpm, or the transmission upshift and downshift points may be incorrect.

Throttle linkage to the transmission should be adjusted so that transmission upshift occurs at approximately 50 rpm below engine governed speed during full throttle operation.

A detent position is incorporated in throttle linkage to provide additional control of transmission shifts. If the shift points are not correct at the to-detent position (full throttle), the linkage requires adjustment. If the to-detent shift points are correct, but the through-detent shift points are not correct, the TV mechanism in the transmission may be sticking. The through-detent position should not allow transmission to upshift and should allow downshifts at highest rpm possible.

> **CAUTION: The transmission should not be operated if throttle linkage is not adjusted correctly because insufficient TV pressure could cause reduction of main pressure, which in turn, might result in clutch slippage and transmission failure.**

<u>Accelerator and TV Linkage Adjustment Procedure (Refer to Fig. 14)</u>

1. Start engine and adjust idle speed to 575-600 rpm, then stop engine.
2. Disconnect clevis (G) from TV lever (F). Position lever (A) 0.060-inch from stop (B).
3. With carburetor throttle lever (C) at idle position and lever (A) 0.060-inch from stop (B), adjust the swivels on rod (I) to provide free-entry into levers (A and B).
4. With carburetor throttle lever (C) at idle position, and TV lever (F) against rear stop (rotated away from engine), adjust clevis (G) on rod (H) for free-entry into lever (F). Then turn clevis (G), to shorten rod, two full turns. Install clevis pin, tighten jam nut and secure clevis (G) to TV lever (F) with cotter pin.

NOTE: On tilt cab models, with carburetor throttle lever (C) in idle position, rod (J) should clear radiator support by 1/8-inch. Lengthen rod (J), as necessary.

IMPORTANT: Adjustment of the detent button (E) is accomplished by relocating the two jam nuts located on either side of the cab floor (see fig. 14). With the accelerator pedal depressed to the thru-detent position (detent button (E) - compressed) ample clearance must exist between the pedal and floor, to assure complete movement of the TV linkage to the thru-detent position.

5. With the accelerator pedal (D) just touching detent button (E), the carburetor throttle lever should be in full throttle position. If adjustment is required, shorten or lengthen rods between accelerator pedal and carburetor throttle lever and, if necessary, reposition detent button (E) to obtain above conditions.
6. Using a tachometer to accurately check engine rpm, road test or dynamometer test vehicle to check for full throttle, full load upshift (5th to 6th). Upshift should occur at approximately 50 rpm below the engine governed speed. If upshifts do not occur at specified rpm, adjust as follows:

a. To raise shift point, shorten rod (H), by turning clevis (G) one turn at a time until the desired shift point is obtained. Tighten jam nut securely against clevis.

b. To lower shift point, lengthen rod (H) by turning clevis (G) off rod one turn at a time until the desired shift point is obtained. Tighten jam nut against clevis.

MANUAL SELECTOR LINKAGE
ADJUSTMENT (Refer to Fig. 15)

The transmission shift control linkage should fully engage all transmission range positions, "R, N, 3-6, 3-5, 3-4, and 1-2," just before the lever hits the "stops" incorporated in the shift control cover. Shift the selector lever through each position while feeling for full engagement in the transmission. Note the position of the selector lever after each shift. Transmission should not engage "3-6" or "R" (Reverse) until selector lever is completely out of the neutral notch. If lever is not properly located or operating, adjust linkage as follows:

1. Locate transmission selector lever (B) against stop in "3-6" position.

2. Check cable for dimension shown in View A-A and adjust if necessary. Anchor cable to bracket at point (D).

NOTE: Threaded portion of shift cable extends 0.88-inch above top-side of bracket, as shown at point (D).

3. Disconnect clevis (G) from transmission manual shift lever (H). Anchor cable securely at point (F).

4. Locate manual shift lever (H) in "3-6" position (3rd notch from the rear). Adjust clevis (G) for free-entry of clevis pin through clevis and manual shift lever (H). Then lengthen clevis (G) by 1½ turns, install clevis pin, tighten jam nut, and secure with cotter pin.

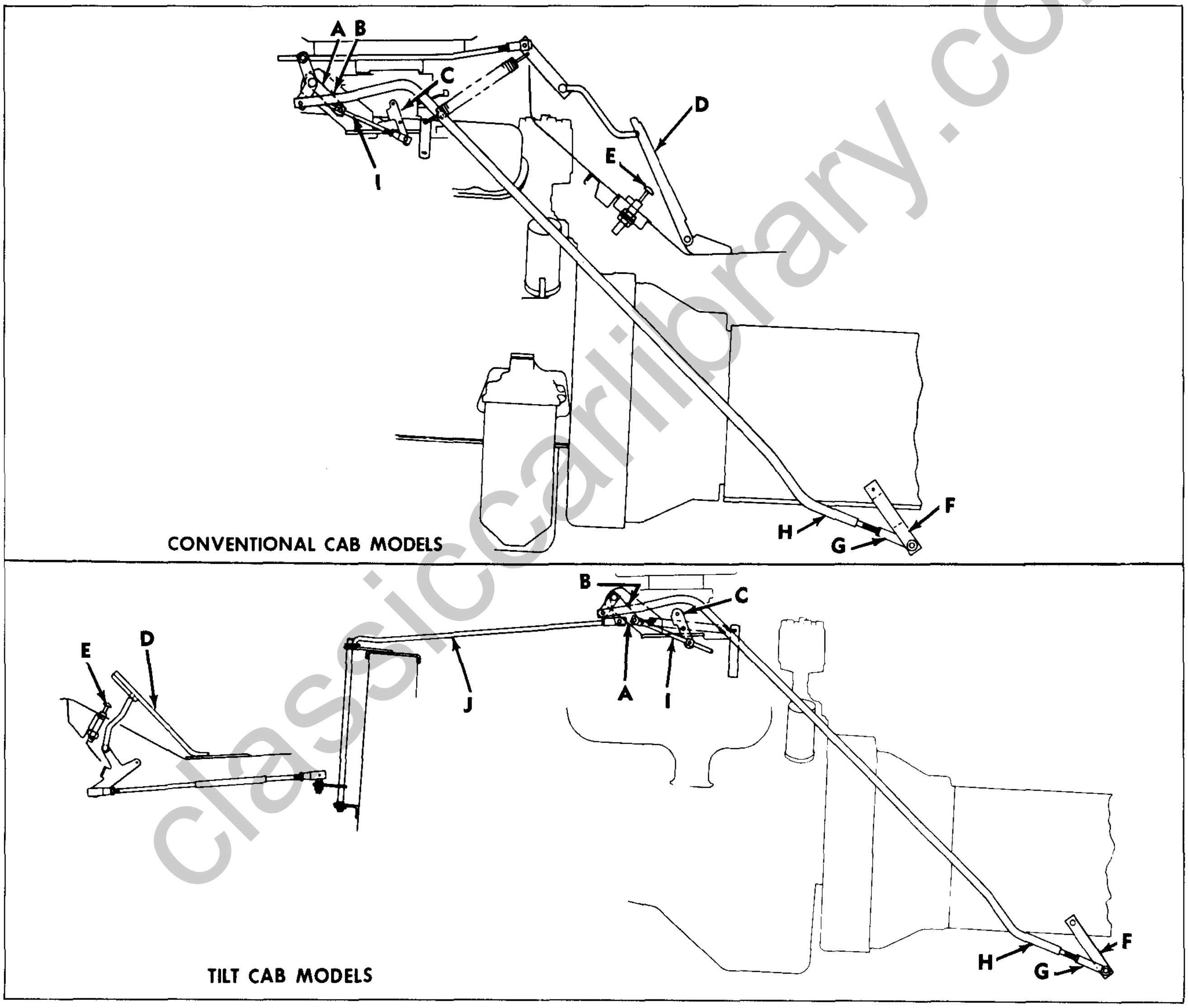


Figure 14—Accelerator and TV Linkage (Allison Transmission)

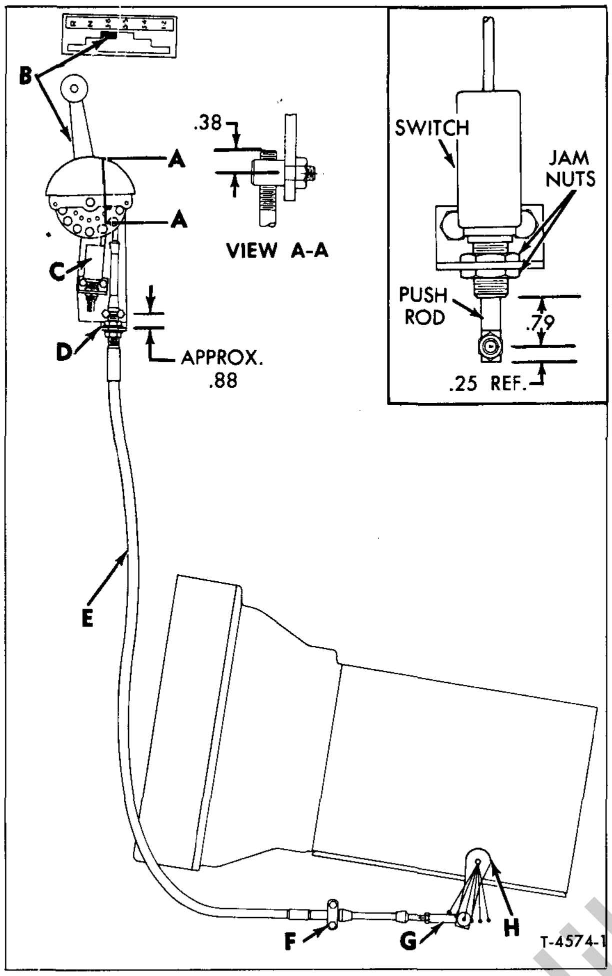


Figure 15—Manual Shift Linkage

5. After completing all adjustments, operate vehicle and check operation of selector lever through all shift ranges. Readjust if necessary.

NEUTRAL SAFETY SWITCH ADJUSTMENT
(Refer to Inset, Fig. 15)

NOTE: "Manual Selector Linkage Adjustment" should be performed as described previously, prior to adjustment of the neutral safety switch.

1. Apply parking brake and perform the following to prevent the vehicle from accidentally starting while performing adjustment:

a. Gas Engine Models - Pull secondary wire out of center socket in distributor cap and ground wire to prevent possible damage to coil.

b. Diesel Engine Models - Place fuel shut-off lever in "SHUT-OFF" position.

2. Move selector lever (B) to "N" (Neutral) position, then referring to Inset, figure 15, loosen jam nuts and adjust length of push rod to dimension shown.

3. With neutral safety switch push rod properly adjusted, tighten jam nuts securely.

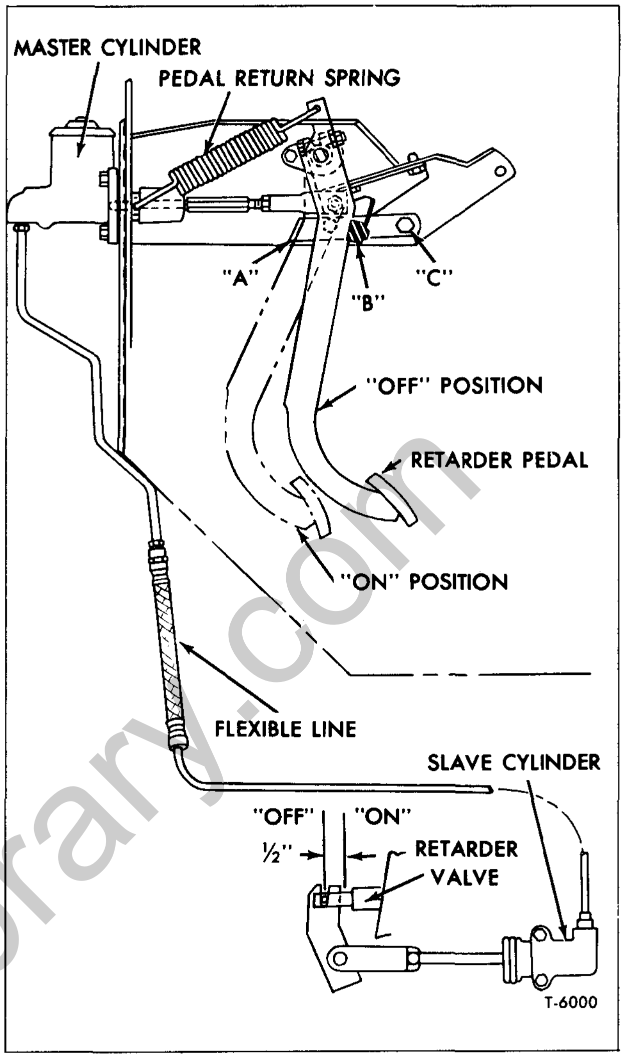


Figure 16—Retarder Controls (Conv. Cab Models)

4. Check each range position of shift linkage to make sure the starter does not operate with the selector lever in any position other than "N." If necessary, re-adjust switch.

5. Reconnect secondary wire to distributor cap, on gas engine models.

RETARDER ADJUSTMENT

The transmission retarder on all truck models equipped with Allison transmission covered by this manual is activated by hydraulic controls.

Conventional Cab Models and TM80

NOTE: Conventional cab models refer to figure 16 and the TM80 refer to figure 17.

1. Loosen lock nut on master cylinder push rod assembly, then turn hex portion of push rod (fig. 18) as necessary to provide 0 to 1/16-inch clearance between push rod and master cylinder

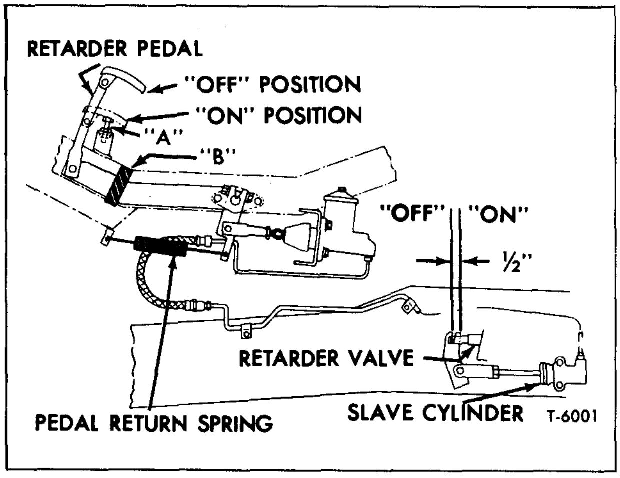


Figure 17—Retarder Controls (TM80)

piston. After making adjustment, tighten lock nut on push rod.

IMPORTANT: Make sure piston contacts snap ring in master cylinder bore when pedal is released. Install boot on master cylinder.

2. With retarder hydraulic system bled, depress the retarder pedal until the retarder valve on the transmission is fully engaged ("ON" position).

3. Holding the retarder pedal in the "ON" position, adjust the pedal stop bracket at "A" (Conv. Cab Models) or stop bolt "A" (TM80) until it touches the pedal as shown. Tighten steering pivot bolt "C" to 8-10 foot-pounds torque (Conv. Cab Models, only).

NOTE: Full travel of retarder valve from "OFF" to "ON" position is ½-inch.

4. Have an assistant depress retarder pedal (in cab) while checking for proper movement of retarder valve. Use a scale to be sure movement of valve from "OFF" to "ON" position is ½-inch.

5. Have assistant release retarder pedal. The retarder valve must return to the "OFF" position (retarder valve fully closed) when the pedal is released. The pedal must return positively and immediately to released position (pedal against bumper stop "B") when foot pressure is released.

6. Readjust linkage, if necessary.

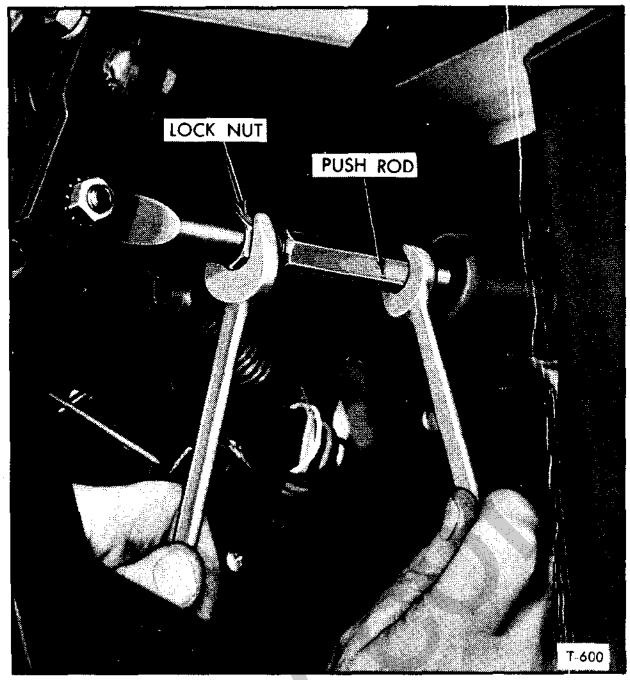


Figure 18—Adjusting Master Cylinder Push Rod (Conv. Cab Models and TM80) (Typical)

Model TM80 (Fig. 19)

1. With retarder hydraulic system bled, depress the retarder pedal until the retarder valve on the transmission is fully engaged ("ON" position).

2. Holding the retarder pedal in this position adjust the stop bolt "A" until it touches pedal as shown. Release the pedal and tighten lock nut against master cylinder.

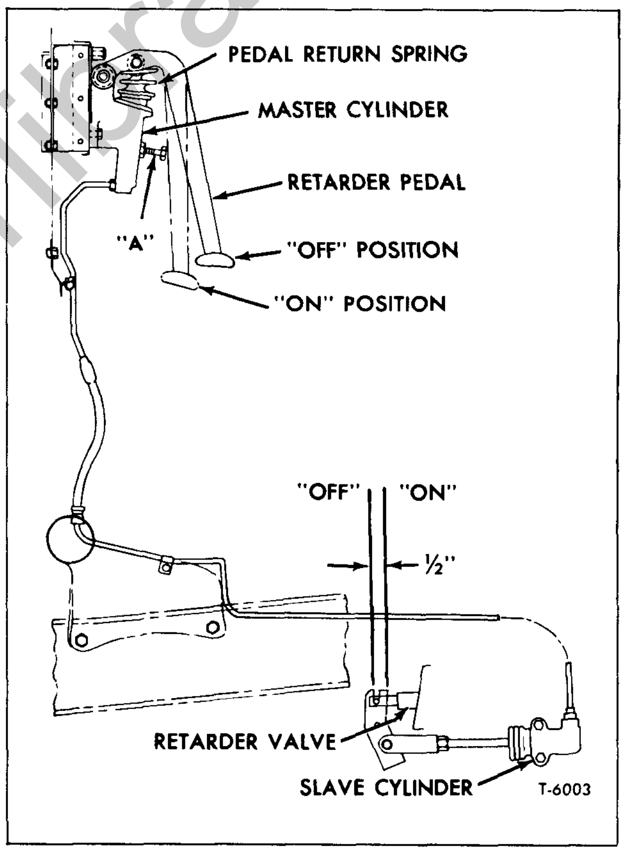


Figure 19—Retarder Controls (TM80)

NOTE: Full travel of retarder valve from "OFF" to "ON" position is ½-inch.

3. Have assistant release retarder pedal. The retarder valve must return to the "OFF" position (retarder valve fully closed) when the pedal is released. The pedal must return positively and immediately to released or "OFF" position when foot pressure is released.

4. Readjust stop bolt, if necessary.

TRANSMISSION ON-VEHICLE SERVICE OPERATIONS

This section contains service information on the following:

TROUBLESHOOTING—MANUAL TRANSMISSION

The following troubleshooting information will assist in locating transmission troubles, but in addition will serve as a guide to find the "cause."

NOTE: Troubleshooting of air controls on Fuller transmissions is covered later in this section under "Air System Servicing."

Whenever possible, road test the vehicle prior to replacement or overhaul of the transmission. Mechanics usually get second or third hand reports of trouble experienced with the unit and these reports do not always accurately describe the actual conditions. Sometimes symptoms seem to indicate trouble in the transmission; while actually the trouble may be caused by the axle, propeller shaft, universal joint, engine or clutch. Therefore, before removing transmission or related components to locate trouble, always road test to check possibility that trouble may exist in other closely associated units. If the mechanic can drive, road testing will be more effective; however, just riding with the driver can be very informative.

If remote controls are used, a careful check of the remote and connecting linkage to transmission and auxiliary must be made. The remote units and linkage must be in good working order if the transmission and auxiliary are expected to shift satisfactorily.

NOISY OPERATION

Noise is usually very elusive and generally not the fault of the transmission; therefore, mechanics should road test to determine if the driver's complaint of noise is actually in the transmission.

NOISE ARISING OUTSIDE TRANSMISSION

In numerous instances, drivers have insisted that the noise was in the transmission, however, investigations revealed the noise to be caused by one of the following conditions:

1. Fan out-of-balance or blades were bent.
2. Defective vibration damper.
3. Crankshaft out-of-balance.
4. Flywheel out-of-balance.
5. Flywheel mounting bolts loose.
6. Engine rough at idle producing rattle in gear train.
7. Clutch assembly out-of-balance.
8. Engine mounts loose or broken.
9. Power take-off engaged.
10. Universal joints worn out.
11. Propeller shafts out-of-balance.
12. Universal joint angles out of phase or at excessive angle.
13. Center bearings in drive line dry - not mounted properly, etc.
14. Wheels out-of-balance.
15. Tire treads humming or vibrating at certain speeds.
16. Air leaks on suction side of induction system - especially with turbo-chargers (if used).

NOISE ARISING IN TRANSMISSION

Mechanics should try to locate and eliminate noise by means other than transmission removal, or overhaul. However, if the noise appears to be in the transmission try to break it down into the following classifications. If possible determine what position the gearshift lever is in when the noise occurs. If the noise is evident in only one gear position, the cause of the noise is generally traceable to the gears in operation.

1. Growl and Humming, or more serious, a grinding noise. These noises are caused by worn, chipped, rough, or cracked gears. As gears continue to wear, the grinding noise will be noticeable, particularly in the gear position that throws the greatest load on the worn gear.

2. Hissing, or more serious a thumping or bumping-type noise. Hissing noises could be caused by bad bearings. As bearings wear and retainers start to break up, etc., the noise could change to a thumping or bumping.

3. Metallic Rattles within the transmission usually result from a variety of conditions. Engine torsional vibrations are transmitted to the transmission through the clutch. A characteristic of the two-plate clutch is a rattling noise, due to oscillation of the intermediate plate drive lugs within the flywheel openings when the clutch is released. In general, engine speeds should be 600 rpm or above, to eliminate objectionable rattles and vibration during the idle. A defective or faulty injector would cause a rough or lower idle speed and a rattle in the transmission. Rattle could also be caused by excessive backlash in power take-off unit mounting.

4. Improper Lubricants, or lack of lubricant can produce noises. Transmissions with low oil levels sometimes run hotter than normal, as there is insufficient lubricant to cool and cover the gears.

5. Squealing, particularly when the transmission is operating at higher speeds, could be caused by one of the free-running gears seizing on the thrust face or fluted diameter temporarily and then letting go. In general, a mild seizure will clear itself up and the transmission will continue to operate very satisfactorily without this defect being known. Refer to Step 7 following:

6. Gear Seizure at high speed, usually accompanied with loud squealing noise. This type of seizure is readily apparent to the driver since the truck will suddenly slow down as if the brakes were being applied. If the truck continues to move ahead, even though the gearshift lever is placed in neutral, it would indicate the floating gear on the mainshaft had seized. Depressing the clutch should interrupt the driving torque. The seized gear could be checked quite readily by depressing clutch and checking the action with the gearshift lever progressively in all shift positions. If releasing the clutch tends to kill the engine, then this gear position has not seized. In other words, the transmission would be in two gears at the same time. By a process of elimination, the gear at fault can be readily identified. Refer to Step 7.

7. Vibration: Gear seizures on thrust faces or fluted diameters are usually caused by vibrations in the power train; this could be engine, propeller shafts, joint angle, rear axle, differentials, etc.

a. Improved highways permit sustained high speeds. The fact that engines and entire power trains can now cruise at a high rpm can introduce vibration frequencies, that were not critical in the past. At slower speeds these items would get by or only pass through critical periods while accelerating or decelerating through the gears.

b. In the past, drive line vibrations such as bent tubes, joints out of phase or alignment, bad angles due to short couples, clutches out-of-balance, gears and shafts in transmission out-of-balance, were fairly obvious. These items will become more critical in vehicles running at sustained high speeds.

c. Critical vibrations associated with higher speeds are not the old thumping or bumping type, but are high frequency vibrations. This type of vibration will cause gear seizures, damaged synchronizers, bearing failure due to retainer bolt failures, promote brinelling, fretting corrosion.

8. Gear Whine is usually caused by lack of backlash between mating gears or improper shimming of power take-off units.

NOISE IN NEUTRAL

1. Misalignment of transmission.
2. Worn or scored main drive gear and/or countershaft bearings.
3. Scuffed gear tooth contact surfaces on gears.
4. Unmatched constant mesh gears.
5. Worn, rough reverse idler gear.
6. Eccentric countershaft gear assembly.
7. Sprung or worn countershaft.
8. Excessive backlash in constant mesh gear.
9. Excessive end play in countershaft, or reverse idler pinion.
10. Worn mainshaft pilot bearing.
11. Scuffed gear tooth contact surface insufficient lubrication.
12. Incorrect grade of lubricant.
13. Incorrect clutch linkage adjustment.

NOISE IN GEAR

1. Worn, or rough mainshaft rear bearing.
2. Rough, chipped, or tapered sliding gear teeth.
3. Noisy speedometer gears.
4. Excessive end play of mainshaft gears.
5. Refer to conditions listed under "Noise In Neutral."

WALKING OR SLIPPING OUT OF GEAR

1. If the units are walking out of gear it could be caused by:

a. Interference or resistance in the shift mechanism preventing full engagement of the sliding clutch gear, or -

b. If the gear has been shifted completely into position some other malfunction which could move the gear out of its proper location.

2. If remote controls are used, the mechanic must satisfy himself that the remote units are satisfactory and that transmission is actually at fault. One other point that should be noted is whether the unit walks out of gear under drive (while pulling a load) or on a coast load. Also, does the gear hop occur on smooth or only on rough roads. A number of items that would prevent full engagement of gears are:

a. Improperly positioned control island shift mechanism which limits full travel forward and backward from the remote neutral position.

b. Improper length shift rods or linkage that limits travel of control island shift mechanism from neutral position.

c. Loose bell cranks, sloppy ball and socket joints.

d. Shift rods, cables, etc., too spongy, flexible, or not secured properly at both ends.

e. Worn or loose engine mounts if forward unit is mounted to frame.

f. Control island shift mechanism mount too flimsy, loose on frame, etc. (tilt cab models).

g. Setscrews loose at remote control joints or on shift forks inside remote or even inside transmission unit.

h. Shift fork pads or groove in sliding gear or collar worn excessively.

i. Worn taper on gear clutch teeth.

j. Transmission and engine out of alignment either vertically or horizontally.

3. A few items which could move the gear or shaft out of proper position, particularly on rough roads are:

a. Use a heavy shift lever extensions.

b. Shift rod poppet springs broken.

c. Shift rod poppet notches worn.

NOTE: When gearshift lever can be held in to prevent jump-out, detent modifications will often correct it. When a gear has been allowed to jump out for a long period generally the cause must be corrected plus replacement of the affected gears.

d. Shift rod bent or sprung out of line.

e. Shift fork pads not square with shift rod bore.

f. Excessive end-play in drive gear, mainshaft or countershaft, caused by worn bearings, retainers, etc.

g. Thrust washers or faces worn excessively, missing, etc.

HARD SHIFTING

1. Sliding gear tight on shaft splines.
2. Insufficient chamfer of sliding gear teeth.
3. Burred mainshaft or sliding gear splines.
4. Misaligned mainshaft.
5. Damaged synchronizer (when used).
6. Improper adjustment of shifting linkage or excessively worn.
7. Worn shift rods.
8. Worn, sprung shifter fork.
9. Wrong lubricant especially if extreme pressure type lubricants are added.
10. Free-running gears, seized or galled on either the thrust face or diameters.

STICKING IN GEAR

1. Insufficient chamfer on detent ball notches.
2. Chips wedged between or under splines of shaft and gear.
3. Misaligned mainshaft and/or countershaft.

CRASH SHIFTING OR RAKING OF GEARS

Raking of gears during the manual shift is usually caused by a defective synchronizer or improper shifting technique for synchronized transmission.

When the shift lever moves directly into the manual shift position without resistance, the raking of teeth will be audible and felt through the gearshift lever. This condition does not always mean the synchronizer is worn out. The following may cause this condition:

1. Quite often, small chips may lodge in the synchronizer temporarily, which prevents proper synchronization and causes raking shifts. Continued operation of the transmission may either embed the chip below the surface of the bronze or reject it and the synchronizer will return to normal functioning.

2. Use of improper oils often causes raking of synchronizer. Heavy oil prevents the synchronizer from breaking through the oil film and doing the job properly. The above condition usually occurs, with cold, heavy oil, but the synchronizer begins to work properly when the transmission oil reaches normal operating temperature.

The use of extreme pressure type lubricants is not recommended. Glazing of the synchronizer due to breakdown of oil is especially common with extreme pressure additives found in multi-purpose or rear axle type lubricants.

Broken synchronizer components sometimes jam under the poppet preventing proper movement of the synchronizer, resulting in crash shifts.

Worn synchronizer components with the loss of clutching action are usually caused by poor driver technique, or failure to control engine speed drop-off during upshift, or failure to bring engine speed nearly up to governor speed when downshifting, causes overwork of synchronizer and failure to shift. Also, drivers who try to shift without using the clutch will burn or wear out manual synchronizers at relatively low mileage.

OIL LEAKS

1. Oil level too high.
2. Wrong lubricant in unit.
3. Non-shielded bearing used at front or rear bearing cap (where applicable).
4. Seals (if used) defective or omitted from bearing cap, wrong type seal used, etc.
5. Transmission breather omitted, plugged internally, etc.
6. Cap screws loose, omitted or missing from remote control, shifter housing, bearing caps, power take-off, or covers, etc.
7. Welch "seal" plugs loose or missing entirely from machine openings in case.
8. Oil drain-back openings in bearing caps or case plugged with varnish, dirt, covered with gasket material, etc.
9. Broken gaskets, gaskets shifted or squeezed out-of-position, pieces still under bearing caps, clutch housing, power take-off, covers, etc.
10. Cracks or holes in castings.
11. Drain plug loose.

BEARING FAILURES

More than 90% of all bearing failures are caused by dirt which is always abrasive.

Dirt may enter the bearings during assembly of the units or be carried into the bearing by the lubricant while in service. Dirt may enter through seals, breather or even dirty containers used for addition or change of lubricant.

Softer material such as dirt, dust, etc., usually form abrasive paste or lapping compounds within the bearings themselves since the unit pressure between the balls and raceways makes a perfect pulverizer. The rolling motion tends to entrap and hold the abrasives. As the balls and raceways wear, the bearings become noisy. The lapping action tends to increase rapidly as the fine steel from the balls and rollway adds to the lapping material.

Hard coarse material such as chips, etc., may enter the bearings during assembly from hammers, drifts, power chisels, etc., or be manufactured within the unit during service from raking teeth, etc. These chips produce small indentation in balls and races. Jamming of these hard particles between balls and races may cause the inner race to turn on shaft, or the outer race to turn in the housing.

CORROSION

Water, acid, and corrosive materials formed by deterioration of lubricant, will produce reddish-brown coating and small etched holes over outer and exposed surfaces of race. Corrosive oxides also act as lapping agent.

FATIGUE

All bearings are subject to fatigue and must be replaced eventually. Your own operating experience will dictate mileage replacement of bearings showing only normal wear.

SHAFTS FITS

Excessive looseness under load is very objectionable because it produces a creeping or slipping of the inner ring on the rotating shaft. This causes the surface of shafts to wear off.

Bearing fits on rotating shafts are usually specified as tight. When play or looseness, even 0.001", exists between the bearing and shaft, there is a very powerful force tending to rotate the inner race on the shaft; this force is caused by the looseness or lost motion between the parts and disappears when no looseness exists.

TRANSMISSION REPLACEMENT—MANUAL TRANSMISSION

The procedures required to remove the manual transmission from vehicles covered by this manual are dependent generally upon the type of cabs (i.e., conventional or tilt), type of body, and lifting equipment available in the repair shop. Operations other than those included in this section may be necessary if the vehicle has special equipment such as a power take-off unit and controls, etc.

The required operations will be obvious upon visual inspection of the vehicle. The instructions contained herein under "Removal" and "Installation" will serve as a guide in accomplishing transmission replacement.

It is important to note that vehicles covered by this manual will have either an "Apron" or "S.A.E. #2" type flywheel housing as shown in figure 1. The "Apron" type flywheel housing is easily identified by the sheet metal pan which covers the entire lower portion of the clutch housing.

The "S.A.E. #2" type flywheel housing completely surrounds the flywheel. A separate clutch housing is used in addition to the flywheel housing. Transmission replacement procedures are different for each type flywheel housing used.

REMOVAL

1. On tilt cab models, disconnect shift linkage from remote control assembly at transmission.

2. On vehicles having a conventional gearshift lever, remove floor mat, remove transmission floor pan cover, then place gearshift lever in neutral position. Remove gearshift lever and control tower assembly from transmission, except on vehicles equipped with Fuller transmissions.

NOTE: On vehicles equipped with Fuller transmissions, bleed air tanks, then remove range shift control lines at air valve on transmission. Remove gearshift lever and control tower assembly from transmission.

3. Place clean lint-free cloth or other suitable covering over opening at top of transmission to prevent entry of dirt or other foreign material.

4. Disconnect electrical wiring from back-up light switch mounted on transmission.

5. Drain lubricant from transmission.

6. Disconnect speedometer cable from transmission adapter.

7. Disconnect clutch control linkage.

8. Disconnect and remove parking brake lever and controls (if used).

9. Disconnect propeller shaft from transmission as described in "PROPELLER SHAFTS" (SEC. 4D) of this manual.

10. Remove engine ground strap and battery cable support clip if attached to transmission or clutch housing.

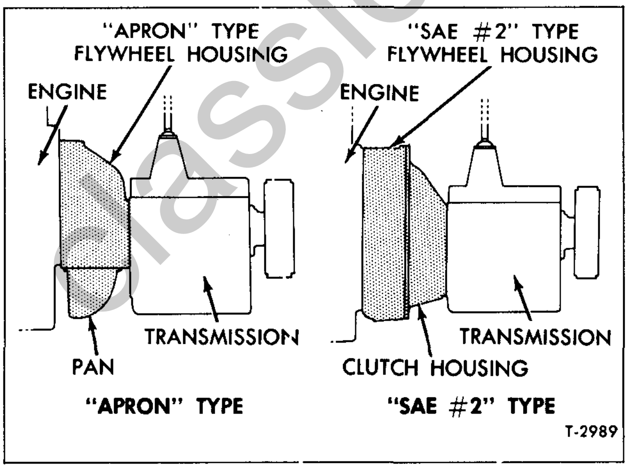


Figure 1—Flywheel Housing Identification

11. If vehicle is equipped with power take-off, remove unit and controls from transmission. Place protective covering over opening.

12. On vehicles equipped with a Fuller transmission, disconnect air-intake line from air filter on transmission. Place protective covering over air filter opening to prevent entry of dirt.

13. Position a suitable dolly or jack under vehicle and adjust to carry weight of transmission.

14. Remove attaching parts that retain transmission to transmission rear mount (when used).

15. Visually inspect to determine if other equipment, lines, or brackets must be removed to permit removal of the transmission.

NOTE: On vehicles which have the engine rear mountings attached to the clutch housing, it will be necessary to support the engine using a suitable dolly or jack at the flywheel housing. Then, remove engine rear mountings as described in ENGINE MOUNTINGS (SEC. 6D) of this manual.

16. Remove clutch housing-to-engine flywheel housing mounting bolts.

17. Move the transmission assembly straight away from the engine, using care to keep the transmission main drive gear shaft in alignment with the clutch disc hub.

CAUTION: When removing the transmission, do not allow weight of the transmission to hang on clutch disc hub, as disc will become distorted, seriously affecting clutch operation.

18. When transmission is free from engine, lower the transmission and move from under the vehicle.

19. If desired, a careful check of clutch components should be made after the transmission has been removed. If the clutch requires repair, refer to "CLUTCHES" (SEC. 7E) in this manual.

INSTALLATION

1. Apply a light coating of High Temperature Grease to the main drive gear bearing retainer and splined portion of transmission main drive gear shaft to assure free movement of components during assembly. Refer to LUBRICATION (SEC. 0) for explanation of "High Temperature Grease."

CAUTION: DO NOT apply an excessive amount of grease in the above areas, as under normal operation this grease would be thrown onto clutch facings resulting in clutch failure.

2. Shift the transmission into high gear.

3. Mount transmission on dolly or jack and move into position under the vehicle.

NOTE: On models equipped with "Apron" type flywheel housing, position the clutch release bearing and support assembly inside the flywheel housing. Be sure the clutch fork properly engages the clutch release bearing.

4. Align the transmission main drive gear shaft with the clutch disc hub by rotating the transmission companion flange. Move the transmission forward, guiding the main drive gear shaft into the clutch disc splines.

IMPORTANT: Avoid springing the clutch when the transmission is being installed to the engine. Do not force the transmission into clutch disc splines. Do not let transmission drop or hang unsupported in the splined hub of the clutch disc.

5. Install clutch housing-to-engine flywheel housing mounting bolts and washers (except on vehicles equipped with "Apron" type flywheel housing). Tighten bolts to 25 to 30 foot-pounds torque.

NOTE: On vehicles equipped with "Apron" type flywheel housing, install transmission-to-flywheel housing mounting bolts and lock washers. Tighten bolts to 60 to 65 foot-pounds torque.

6. If the engine rear mountings were removed, reinstall the mounts as covered in ENGINE MOUNTINGS (SEC. 6D) of this manual. Be sure all mounting bolts are properly torqued.

7. Install transmission rear mount (when used) as described under "Transmission Rear Mount Installation."

8. On vehicles equipped with Fuller transmission, connect air-intake line to air filter.

9. If vehicle is equipped with power take-off, reinstall unit and controls on transmission.

10. Install engine ground strap and battery cable support clip, if attached to transmission.

11. Connect propeller shaft to transmission as described in "PROPELLER SHAFTS" (SEC. 4D) of this manual.

NOTE: Proper torque values for the mainshaft flange or yoke retaining nut is given under "Rear Oil Seal Replacement" later in this section.

12. Connect mechanical parking brake lever and controls (when used). Adjust brake, if necessary, as outlined in "PARKING BRAKE" (SEC. 5C).

13. Connect electrical wiring to back-up light switch mounted on transmission.

14. Reconnect clutch control linkage.

15. Connect speedometer cable to adapter at transmission (when used).

NOTE: Some vehicles are equipped with a speedometer driven from the front axle.

16. If other equipment (exhaust pipe, support brackets, etc.) was removed, reinstall these parts.

17. Shift the transmission into neutral. On vehicles equipped with a conventional gearshift lever, reinstall gearshift lever and control tower assembly.

18. On tilt cab models, reconnect shift control rods to the transmission.

19. On vehicles equipped with Fuller transmission, reconnect range shift control lines to air valve on the transmission.

20. Fill transmission with lubricant recommended in LUBRICATION (SEC. 0) of this manual.

21. If necessary, adjust clutch or transmission control linkage to achieve proper transmission operation.

TRANSMISSION REAR MOUNT INSTALLATION (Refer to Figs. 2, 3, 4, and 5)

NOTE: For proper torque on frame-to-rear mounting bracket attaching parts (if removed), refer to "Torque Specifications."

Crossmember Mountings

NOTE: The following installation instructions apply to transmissions with rear mounts as shown in figure 2.

1. With clutch housing-to-flywheel housing

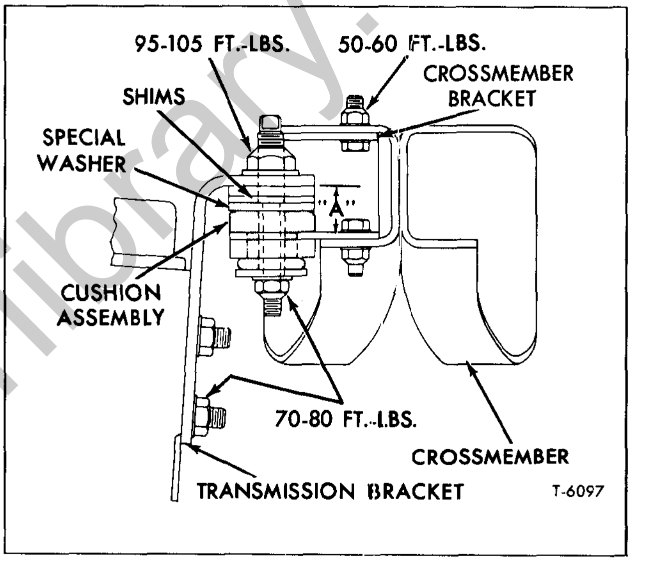


Figure 2—Transmission Rear Mounting (Tilt Cab with SP 8716-3B or SP 8516-3B)

Model Application Chart

Truck Models	Transmission	Rear Mounting
DC, DH, FH 90	SP8716-3B & SP8516-3B	Figure 2
MH 90	SP8716-3B & SP8516-3B	Figure 3
JI 90	RTO913	Figure 4
FH 90	RTO913	View A, Fig. 5
HN, JN 90 FC, FI, FN 90	RTO913	View B, Fig. 5
DC, DH, DN 90	RTO913	View C, Fig. 5
DI 90	RTO913	View D, Fig. 5

bolts installed and engine rear mounts installed, place each cushion assembly and washer on crossmember (in normally installed position).

2. Carefully lower the transmission and engine so that the transmission and engine weight is supported by the engine mountings.

3. Measure the distance between transmission bracket and crossmember bracket (Dimension "A"). Add 1/16-inch to Dimension "A" (allowing for uniform distribution of engine and transmission weight to both engine and transmission mountings), then subtract 11/16-inch (installed thickness of cushion assembly between special washer and crossmember bracket). This final dimension is the thickness of shims required at the rear mounts.

NOTE: There may be a difference in gap between each side of the rear mountings. If this condition exists, determine the thickness of spacers required for each side of the mounting as explained in Step 3. Add these two dimensions and divide by two. This thickness of shims is required at each side of the rear mounting.

4. Install the two special bolts (as shown) and secure with lower spacer, washer, and nut. Tighten lower nut to 70-80 foot-pounds torque.

5. Raise transmission sufficiently to allow insertion of shims, as determined in Step 3.

NOTE: Shims are U-shaped for ease in installation and are available in three sizes: 0.25", 0.12", and 0.06".

6. Following placement of shims, secure transmission bracket to crossmember with washer and upper nut. Tighten upper nut to 95-105 foot-pounds torque.

IMPORTANT: Check the installed height of the cushion assembly (lifting equipment removed) which should be 11/16-inch. Reduce shim-pack if less than 11/16-inch and increase shim-pack if more than 11/16-inch, accordingly.

Support Beam Mounting - Spicer Transmission

NOTE: The following installation instructions apply to transmissions with the rear mounts as shown in figure 3.

1. With cross beam attached to the transmission, carefully lower the power plant so that the transmission and engine weight is supported by the engine mountings.

2. Measure the space between outer ends of cross beam and rear mounting brackets (Dimension "A"), then select spacers with a thickness approximately 1/16-inch greater than existing gap.

NOTE: There may be a difference in gap between left- and right-hand sides of the rear mounting. If this condition exists, measure the total gap between the left- and right-hand sides and divide by two, then add 1/16-inch. This thickness of spacers is required at each side of the rear mounting to provide the proper weight distribution of the transmission.

3. Jack up transmission high enough to permit installation of spacers. Install all attaching parts as shown in figure 3. Be sure all attaching parts are properly torqued.

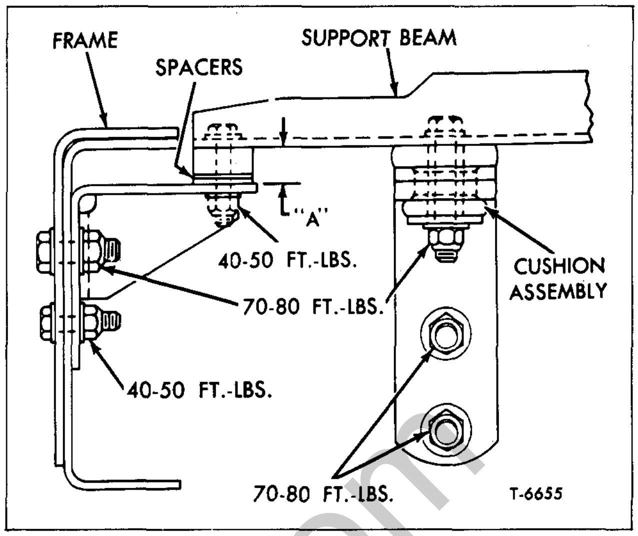


Figure 3—Transmission Rear Mounting (Conv. Cab with SP 8716-3B or SP 8516-3B)

Support Beam Mounting - Fuller Transmission

NOTE: The following installation instructions apply to transmissions with the rear mounts as shown in figures 4 and 5.

1. If support beam has not been removed from vehicle, raise transmission until contact is made with support beam. Secure transmission to support beam.

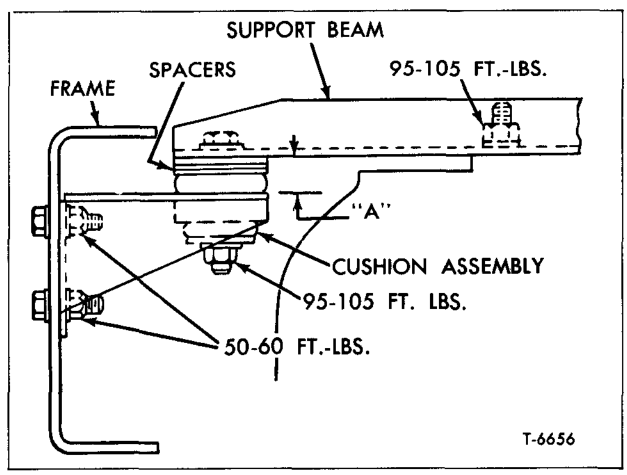


Figure 4—Transmission Rear Mounting (Conv. Cab with RT 0913, except HN, JN 90)

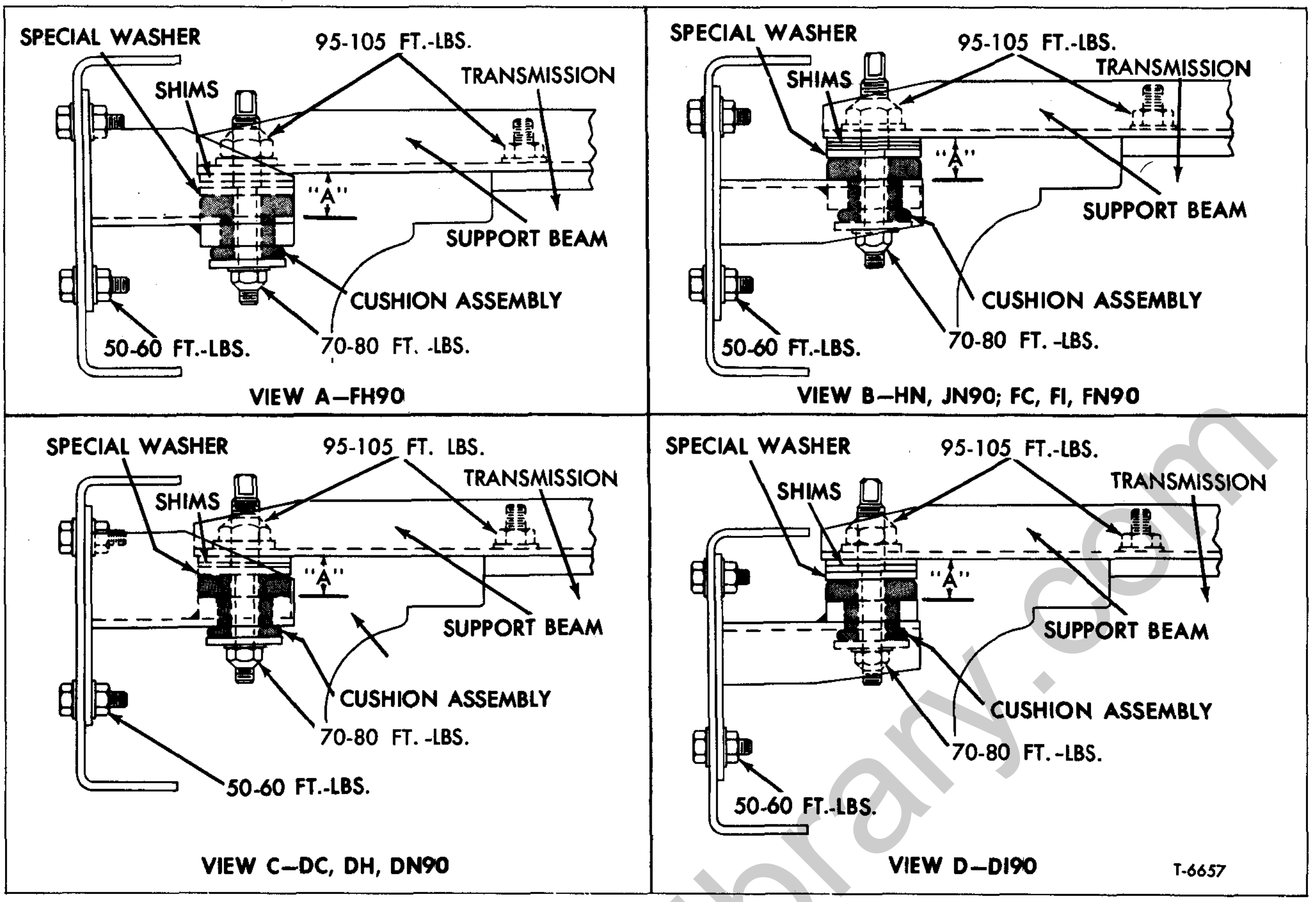


Figure 5—Transmission Rear Mounting (Tilt Cab Models and HN, JN 90 with RT 0913)

2. If support beam has been removed from vehicle install transmission as follows:

a. With clutch housing-to-flywheel housing bolts installed and engine rear mountings installed, place a cushion assembly and special washer on each rear mounting bracket.

b. Attach support beam to transmission. Tighten retaining nuts to 95-105 foot-pounds torque.

c. Carefully lower the transmission and engine so that the weight of the transmission and engine is supported by the engine mountings.

d. Measure the distance between support beam and rear mounting bracket (Dimension "A"). Add 1/16-inch to Dimension "A" (allows for uniform distribution of engine and transmission weight to both engine and transmission mountings), then subtract 11/16-inch (installed thickness of cushion assembly between special washer and rear mounting bracket). This final dimension is the thickness of shims (including special washer) required at the rear mounting.

NOTE: There may be a difference in gap between the right- and left-hand sides of the rear mounting. If this condition exists, determine the thickness of shims required for each side of the mounting as explained in Step d. Add these two dimensions and divide by two. This thickness of shims is required at each side of the rear mounting.

e. Raise transmission sufficiently to permit installation of shims and other rear mount attaching parts as shown in figures 4 and 5. Be sure all attaching parts are properly torqued.

NOTE: Shims are U-shaped for ease in installation and are available in three sizes: 0.25", 0.12", and 0.06".

f. Check the installed height of cushion assembly between special washer and rear mounting bracket (lifting equipment removed) which should be 11/16-inch. Reduce shim-pack if less than 11/16-inch and increase shim-pack if more than 11/16-inch, accordingly.

TRANSMISSION REPLACEMENT—ALLISON AUTOMATIC TRANSMISSION

The following procedures apply to all vehicles covered by this manual. However, it may be necessary to remove air tanks, fuel tanks, special equipment, etc., on some vehicles to provide clearance before the transmission is removed.

IMPORTANT: The torque converter and transmission must be removed from, or installed into the vehicle as a unit. The transmission cannot be removed from or installed on the converter in the vehicle.

REMOVAL

1. Block vehicle so that it cannot move. Disconnect ground strap from battery negative (-) post. Remove the spark plugs so the engine can be turned over manually.
2. Loosen the transmission oil filter cover by loosening cover strap retaining bolt and nut to allow transmission oil to drain. Do not remove the filter cover from the oil pan as oil will gush out too quickly. When oil stops flowing, tighten the cover strap.
3. Disconnect range shift cable from range selector lever at left side of transmission.
4. Disconnect TV (throttle valve) rod from TV lever at left-side of transmission.
5. Disconnect retarder linkage on left side of transmission.
6. Remove starter motor as described in ENGINE ELECTRICAL (SEC. 6Y) of this manual.
7. Remove the oil level gauge (dipstick). Disconnect oil filler tube at right side of transmission oil pan and remove tube clamp. Remove vent hose clamps and lift out filler tube and vent hose assembly. Replace dipstick in tube and cover the vent hose and oil pan openings to prevent entry of foreign material.
8. Disconnect oil cooler lines from fittings on the retarder valve body. Plug line ends and valve body openings with clean lint-free material. Disconnect wiring from hot oil switch.
9. Disconnect the speedometer shaft fitting from adapter at rear of the transmission.
10. Disconnect the propeller shaft from transmission as described in "PROPELLER SHAFTS" (SEC. 4D) in this manual.
11. Disconnect the mechanical parking brake linkage at right side of transmission (if used).
12. Through the starter opening in the flywheel housing, use a pry-bar, as necessary to manually turn the flywheel. As the flywheel is rotated, remove the six nuts retaining flywheel flex plate assembly to converter pump cover.

CAUTION: DO NOT rotate flywheel by using wrench on the nuts or prying against studs on converter cover.

13. Support the transmission with a 1,000 lb. (minimum) transmission floor jack (fig. 6). The jack must be positioned so transmission oil pan will not support the weight of the transmission. Fasten a safety chain over top of transmission and to both sides of the jack.
14. Remove converter housing-to-crossmember bolts. Carefully raise engine transmission assembly, sufficiently to allow converter housing to clear cradle type crossmember during removal of transmission.
15. Place a support under rear of engine. Remove converter housing-to-flywheel housing attaching bolts and washers.
16. Move transmission carefully straight-away from the engine, lower the assembly and move it out from the vehicle.

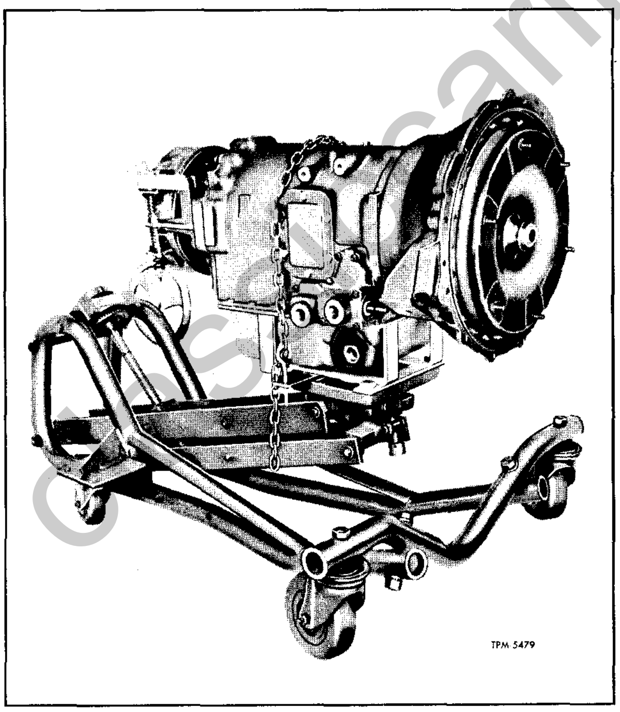


Figure 6—Transmission Mounted on Hydraulic Jack

INSTALLATION

1. Raise vehicle sufficiently to allow installation of transmission. With transmission assembly properly mounted on transmission jack as shown in figure 6, move transmission into position aligning converter housing with flywheel housing. Check for and clean away any foreign material in flywheel pilot hole and on flywheel flex plate assembly and converter housing face. Rotate flywheel as necessary so that the six studs on the converter cover can freely enter holes in engine flywheel flex plate assembly. Carefully move transmission assembly toward engine so studs can enter holes in flex plate and so that pilot on transmission enters pilot hole in center of flywheel.

2. Install bolts and washers that attach converter housing to engine flywheel housing. Tighten bolts to 25-30 foot-pounds torque.

3. Loosely, install six nuts that hold converter cover to flywheel flex plate. On next hand rotation of engine, tighten nuts to 30-40 foot-pounds torque.

4. Carefully lower engine and transmission assembly onto engine rear mounts. Tighten engine rear mounting bolts to 60-70 foot-pounds torque. Then bend lock tabs down over head of each bolt. Remove lifting equipment from beneath vehicle.

5. Remove plugs from oil cooler lines and transmission valve body openings. Be sure fittings are clean and lint-free, then connect oil cooler lines to transmission. Connect wiring to oil temperature warning switch on transmission.

NOTE: Oil temperature warning switch is located in the oil cooler line fitting in the forward opening in retarder valve body.

6. Install the oil filler tube and clamp at right side of transmission oil pan. Check for serviceable condition of transmission vent tube and clamps, then install these parts. Install oil level gauge.

NOTE: Cover oil filler tube upper opening to keep out foreign material while being pushed up into engine compartment during installation.

7. Connect speedometer shaft fitting to adapter at rear of transmission.

8. Connect propeller shaft to transmission as described in "PROPELLER SHAFTS" (SEC. 4D) in this manual.

9. Connect parking brake linkage (if used) at side of transmission.

10. Connect retarder and TV linkage on left side of transmission.

11. Connect the range selector cable to shift lever at left side of transmission.

12. Install starting motor as described in ENGINE ELECTRICAL (SEC. 6Y) in this manual.

13. Install new oil filter element in auxiliary oil filter (if used) and add transmission oil as described in LUBRICATION (SEC. 0) in this manual.

WARNING: TO PREVENT ACCIDENTAL STARTING OF VEHICLE, WHILE POSSIBLY IN A DRIVE RANGE, BE SURE IGNITION SWITCH IS IN THE "OFF" POSITION BEFORE PROCEEDING TO STEP 14.

14. Install spark plugs and connect battery ground strap, previously disconnected (for safety).

15. If necessary, refer to "TRANSMISSION CONTROL LINKAGE (SEC. 7A) in this manual for adjustment of manual shift linkage, accelerator and TV linkage, and the retarder linkage.

REAR OIL SEAL REPLACEMENT—MANUAL TRANSMISSION

The lip-type oil seal used at rear of Clark, Fuller, and Spicer transmissions can be replaced without removing transmission from vehicle.

Replace rear oil seals as follows:

REMOVAL

1. Drain lubricant from transmission.

2. Disconnect propeller shaft from transmission as described in "PROPELLER SHAFTS" (SEC. 4D) in this manual.

3. Remove parking brake (when used) from rear of transmission as described in "PARKING BRAKE" (SEC. 5C) in this manual.

4. Disconnect speedometer cable and remove speedometer driven gear from mainshaft rear bearing cap.

5. Using flange or yoke holding tool, remove the output yoke or companion flange nut. Pull output yoke or companion flange off mainshaft.

6. Remove mainshaft rear bearing cap and gasket. Discard gasket.

7. Using a suitable puller, remove oil seal from rear bearing cap. Discard oil seal.

INSTALLATION

1. Install new oil seal in mainshaft rear bearing cap using a suitable seal installer as shown in figure 7, with lip of seal pointing toward transmission case.

NOTE: Sealing cement should be used at the outer diameter of oil seal to prevent leakage. Wipe off excess cement.

2. Clean all gasket surfaces, then install rear bearing cap and oil seal assembly with a new gasket to transmission case. Tighten cap screws firmly.

NOTE: Oil return passage in rear bearing cap must line up with oil passage in transmission case.

3. Install output yoke or companion flange on mainshaft. Using flange or yoke holding tool, install retaining nut. Refer to "Torque Specifications" for proper torque.

4. Install speedometer driven gear, then connect speedometer cable.

5. Install parking brake (when used) to transmission as described in "PARKING BRAKE" (SEC. 5C) in this manual. Adjust brake if necessary.

6. Connect propeller shaft to transmission as described in "PROPELLER SHAFTS" (SEC. 4D) in this manual.

7. Refill transmission with lubricant as described in LUBRICATION (SEC. 0) in this manual.

TORQUE SPECIFICATIONS

Companion Flange or
Output Yoke Retaining Nut

Transmission Model	Nut Torque (Ft.-Lbs.)
Clark 282V, 285V, or 325V	400-450
Clark 401V or 408V	550-600*
Fuller T905	500-550
Fuller RT910 or RTO913	550-600
Spicer 5652, 5752, 6852, or 6853	500-550
Spicer 7352, 7452, 8552, or 8554	500-550
Spicer 8516-3B or 8716-3B	500-550

*Secure with cotter pin.

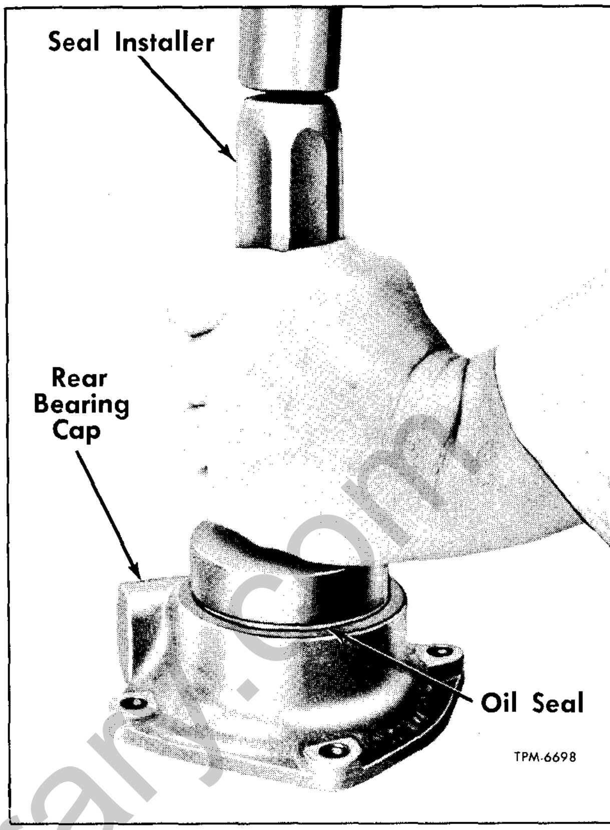


Figure 7—Installing Mainshaft Rear Bearing Cap Oil Seal

AIR SYSTEM—FULLER TRANSMISSION

The air systems shown in figures 8, 9, and 10 consist of: Air filter, regulator, air valve, control valve, shift cylinder, fittings, connecting air lines, and on the RTO913, splitter control valve and splitter shift cylinder.

The operation of the air system on Fuller transmissions covered by this manual, is basically the same, with the exception of the splitter gear air system on the RTO913.

On the range shift system, constant regulated air is supplied to the bottom port of the air valve and to the "IN" port of the control valve. With the control button down, air passes through the control valve and to the end port of the air valve. This permits air from the constant supply to flow through the low range port in front side of air valve and to the shift cylinder air port. Air on this port moves the shift piston and bar to the rear to engage the low range gear.

With the control button up the control valve is closed and air is removed from end port of air valve. This permits air from the constant supply to flow through the high range port in rear side of air valve tp the shift cylinder cover air port. Air on this port moves the shift piston and bar forward to engage the high range gear.

When the control button is moved from one position to another, air from the previously charged line exhausts through the breather in air valve.

On the splitter gear air system (figs. 9 and 10) used on the RTO913 transmission, constant air is always on the front side of piston, supplied through channels in the cover and cylinder housing (fig. 17). This supply does not pass through the insert valve. Air is not exhausted from the front side of piston when air is applied to backside of piston.

With the splitter lever on the splitter control valve assembly in the "DIRECT" position: No air passes through the control valve as it is in the closed or off position. The insert valve (fig. 17) in the cylinder cover is open and constant regulated air is supplied to the backside of shift piston, moving the shift bar forward into direct position.

With the splitter lever on the splitter control

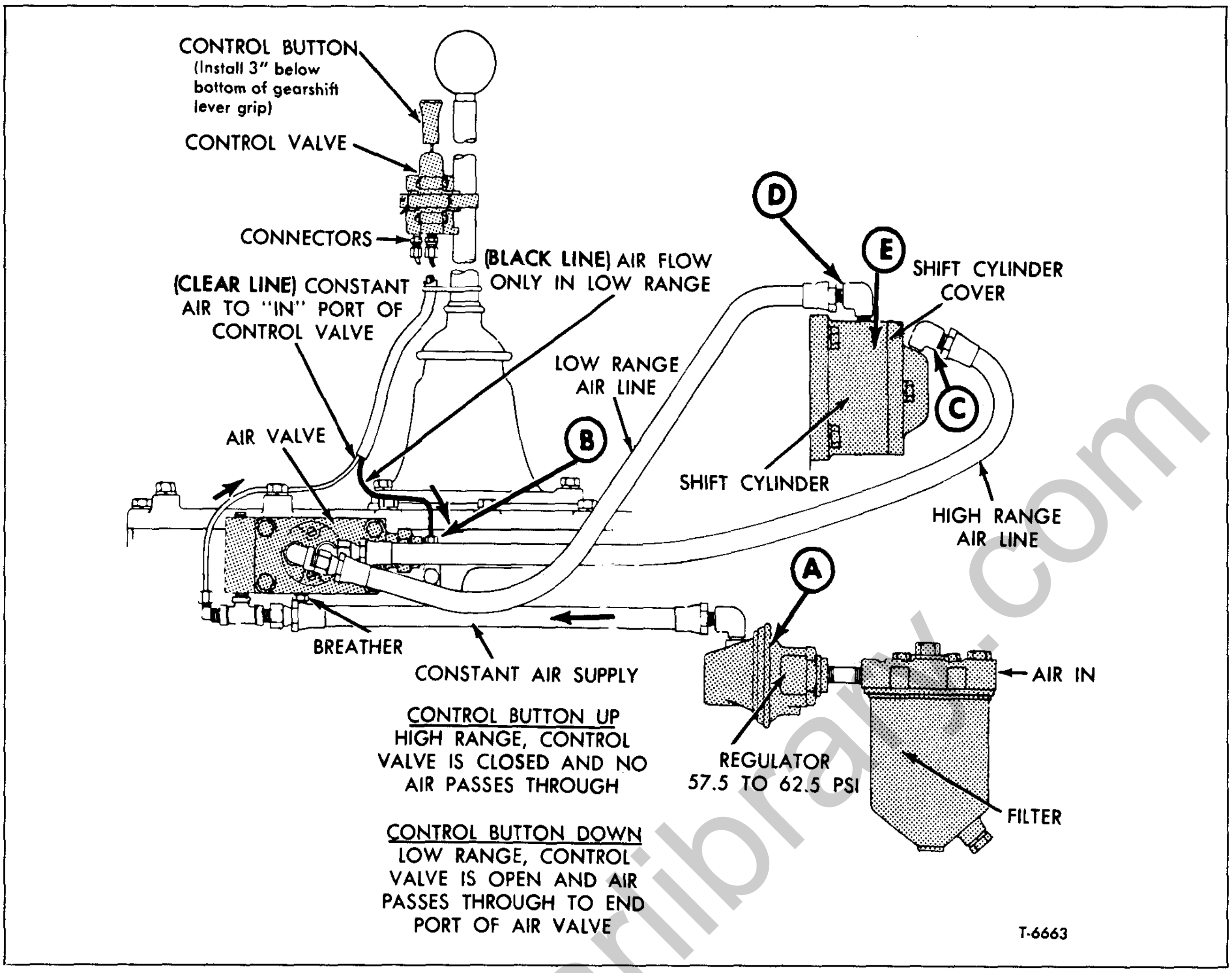


Figure 8—Typical Range Shift System (Fuller Transmission)

valve assembly in the "OVERDRIVE" position: The splitter control valve is open and air is applied to the insert valve in the cylinder cover. This closes the insert valve which shuts off the constant air supply to backside of piston. Air from backside of piston is exhausted through the insert valve and out the bottom port of cover. With air now only on front side of piston the shift bar is moved to the rear into the overdrive position.

TROUBLESHOOTING AIR SYSTEM

RANGE SHIFT SYSTEM (Refer to Fig. 8)

If the transmission fails to make a range shift or shifts too slow, the fault is most likely in the air system. It is most important to check the entire air system before condemning a single component. To check the air system and pin-point the trouble area, the following procedures are recommended, using the check points indicated by letters in figure 7.

NOTE: Checks are to be made with the engine not running, normal vehicle air pressure, and gearshift lever in neutral.

Air Lines - Improperly Connected

1. Move the control button up and down, from one range to another.

2. If lines are crossed between the control valve and the air valve on transmission, there will be a steady flow of air from the exhaust in control valve if button is held in the up position (correct as necessary).

3. If lines are crossed between the air valve on transmission and the air or shift cylinder, the transmission gearing will not correspond with the button position. Low range, down position of button, will result in high range gear engagement in the transmission and vice versa (correct as necessary).

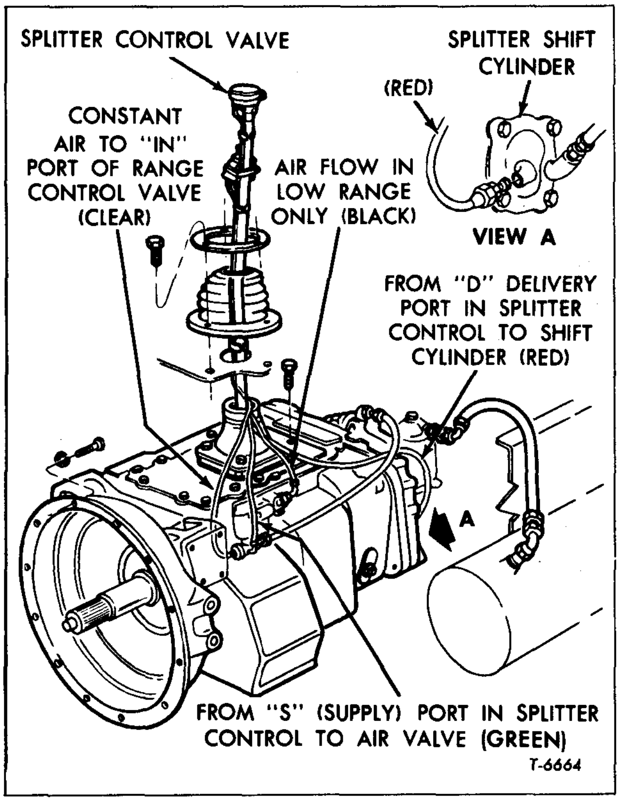


Figure 9—RTO 913 Air Controls (Conv. Cab Models)

Air Leaks

Coat all air lines and fittings with soapy water or air leak detection fluid and check for leaks, moving control button to both positions (high and low range).

1. If there is a steady leak out the exhaust of the control valve, there are defective parts or O-rings in the control valve.
2. If there is a steady leak out the breather on the air valve: There is a defective O-ring in the air valve; or there is a leak past O-rings on the shift cylinder piston (see Check Point "E").
3. If transmission fails to shift into low range or is slow to make the shift and the transmission case is pressurized, see Check Point "E."
4. Tighten loose connections and replace all defective parts.

Check Point "A"

1. If there is a steady leak from exhaust port, this indicates a ruptured diaphragm, or that dirt and rust have clogged the regulator piston in the input port at the seal. Inspect and replace diaphragm if necessary. Clean regulator.
2. Cut off the vehicle air pressure and install air gauge into the air system at the output port of the regulator valve. Bring the vehicle air pressure to normal. Check the pressure reading which should be 57.5 to 62.5 psi.
3. If gauge reads full line pressure, plus steady leak in regulator exhaust port, this indicates ruptured diaphragm or dirty regulator.
4. If gauge registers less than line pressure but above 64 psi, this indicates the V-shaped piston spring is weak, or that piston seal is defective.
5. Pulsating gauge indicates loose lock ring which attaches the two sections of the air regulator.
6. If, after cleaning regulator and replacing worn parts, the regulator still does not read within limits, regulated pressure can be changed by the addition or removal of shims.
   a. Add shims to raise air pressure.
   b. Remove shims to lower air pressure.
7. One shim is equal to approximately 2 psi pressure change.
8. Only as a last resort should an adjustment be made with the screw in end cap of regulator. This adjustment has been set for correct operating limits. Any deviation from these limits, especially on regulators which have been in operation for some time, will in most cases be caused by dirt or worn parts. Adjustment of screw will give only a temporary remedy.
   a. Turning screw in (clockwise) raises air pressure.
   b. Turning screw out lowers air pressure.

Check Point "B"

1. Pull the control button up to high range and disconnect the 1/8" nylon air line from "out" port of control valve at the air valve.
2. When control button is pushed down a steady blast of air will flow from the control valve (port where line was disconnected). Air will shut off when button is pulled up. This indicates that control valve is operating correctly. Reconnect air line.
3. If control valve does not operate correctly, check for restrictions or leaks. Leaks indicate defective O-rings in the control valve.

Check Point "C"

1. Push the control button down to the low range position, then disconnect the high range air line, either at fitting on shift cylinder or at side port of air valve.
2. Pull the control button up. There should be a steady flow of air from the high range port on the air valve. Push button down to shut off air.
3. With vehicle engine not running, move the gearshift lever to any gear position. Pull the control button up; there should be no air at the high range port. Move the gearshift to neutral; there should now be a steady flow of air from the high range port. Push control button down to shut off air and reconnect the high range air line.
4. If the air system operates incorrectly, this

indicates that the air valve is defective, or that actuating parts in shifting bar housing are jammed or defective.

Check Point "D"

1. Pull the control button up to high range and disconnect the low range air line, either at fitting on the shift cylinder or at side port of air valve.

2. Repeat procedures under Check Point "C," reversing the position of the control button in order to check low range operation.

Check Point "E" (Refer to Fig. 15)

If any of the seals in the range shift cylinder are defective, the range shift will be affected. The degree of lost air will govern the degree of failure, from slow shift to complete failure.

1. Leakage at seal "A" or "B" results in failure to shift into either low or high range; steady leak out air valve breather in both ranges.

2. Leakage at seal "C" results in failure to shift into low range; pressurizing of transmission.

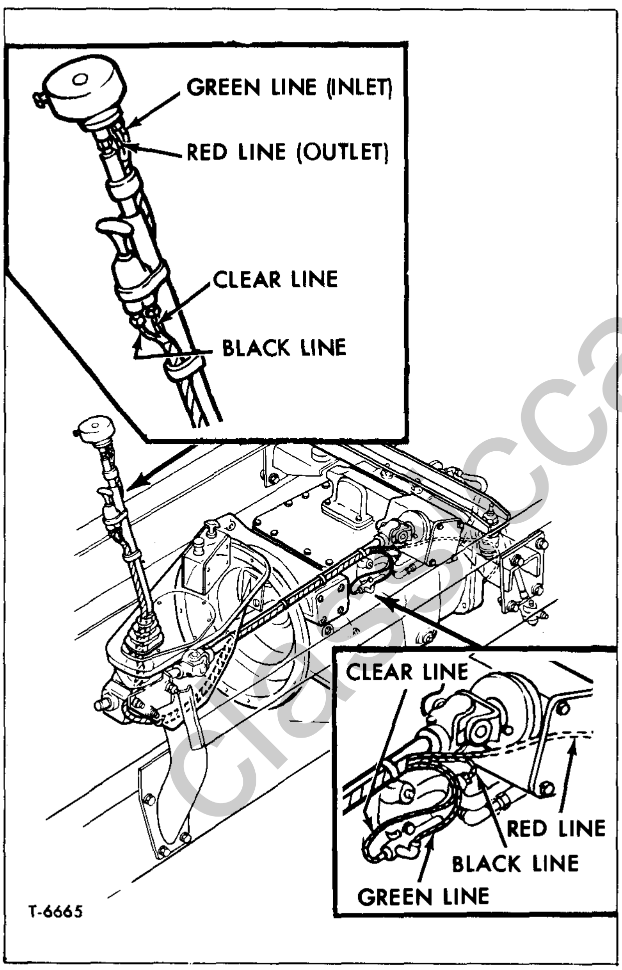


Figure 10—RTO 913 Air Controls (Tilt Cab Models)

SPLITTER GEAR AIR SYSTEM (RTO913)
(Refer to Figs. 9 and 10)

Air Supply

1. Check lines for leaks.

2. Check lines to see that they are not blocked due to crimped lines.

3. With normal vehicle air pressure, disconnect ¼" air line at side port of splitter cylinder cover. There should be a steady flow of air at all times. If air gauge is available, take pressure reading which should be 57 to 62 psi.

4. Remove the 1/8" O.D. air line at the supply port of the splitter control. There should be a constant flow of air from this line at all times.

Splitter Control Valve

1. With the splitter control in the "DIRECT" position, disconnect the 1/8" O.D. red air line from the center port of the splitter cylinder cover. There should be no air on this line.

2. Move the splitter control to the "OVERDRIVE" position; there should now be a steady flow of air from this line. Air flow will stop when splitter control is moved to the "DIRECT" position.

NOTE: If the above results are not obtained, this indicates a faulty splitter control valve. Cause can be defective parts, damaged O-ring, loose top plate screw or blocked air line.

3. Any steady flow of air from the splitter control valve exhaust port indicates a faulty splitter control valve or incorrect hook-up. Cause can be defective parts, damaged O-ring, loose top plate screw or reversed air lines on control.

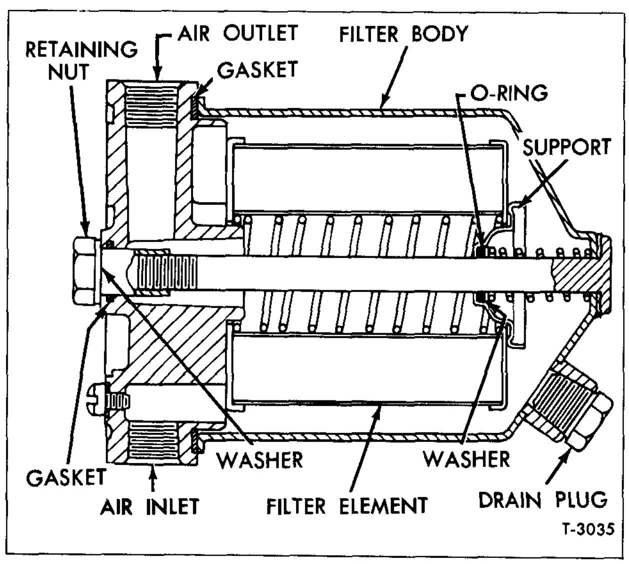


Figure 11—Fuller Transmission Air Filter

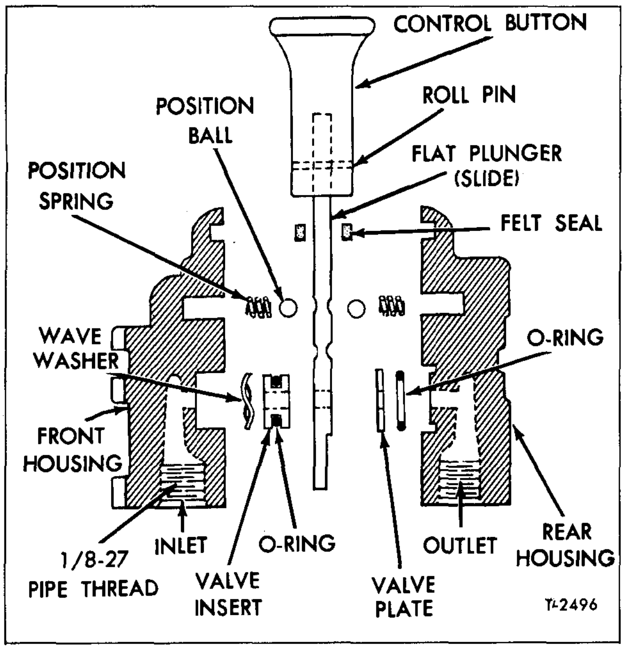


Figure 12—Shift Lever Control Valve

Splitter Shift Cylinder

There are three O-ring seals in the shift cylinder as shown in figure 17.

1. Leak at Seal A -- Possible failure to shift into overdrive, or slow shift to overdrive, plus pressurizing of transmission.
2. Leak at Seal B and C -- Slow shift in either direction, plus leak out cover exhaust when in overdrive.

Splitter Shift Cylinder Cover

1. Exhaust Port -- Any constant flow of air out the cover exhaust port usually indicates a faulty insert valve. Exhaust should occur briefly ONLY when the splitter control is moved from "DIRECT" to "OVERDRIVE."
2. Insert Valve -- A faulty insert valve, leaking at the outer diameter O-rings or inner seals will result in failure to shift. Two indications of O-ring or seal failures are:
   a. Constant leak out cover exhaust.
   b. Constant leak out splitter control exhaust with splitter control in "DIRECT."

The three O-rings on outer diameter of the insert valve can be replaced. If an inner seal is damaged, the entire insert valve will have to be replaced.

AIR SYSTEM SERVICING

AIR FILTER (Refer to Fig. 11)

The air filter used on Fuller transmissions contains a replaceable element. This element should be replaced every 10,000 miles or more often under high humidity conditions.

NOTE: Vehicles that operate under high humidity conditions will collect water in the lower portion of the filter body. This water should be drained off at regular intervals by loosening the drain plug until all the water is removed. Check filter regularly under freezing conditions as air will not flow through an ice coated filter element.

SHIFT LEVER CONTROL VALVE

Removal (Refer to Fig. 8)

1. Disconnect the air lines from the control valve.

NOTE: Be sure to place protective caps over the ends of the air lines to prevent entry of dirt or other foreign material.

2. Remove the gearshift lever knob.
3. Loosen the control valve mounting clamp and remove the control valve and mounting clamp from the gearshift lever. Remove the mounting clamp from the control valve.

Disassembly (Refer to Fig. 12)

1. Place control valve with rear housing (outlet side) on the workbench and remove housing attaching parts. Carefully separate the front and rear housings.
2. Remove the slide and the two position balls and springs.
3. Remove the valve plate and O-ring from the rear housing.
4. Remove valve insert from front housing and remove the O-ring from valve insert.
5. Remove the wave washer installed under the valve insert.
6. Remove two felt seals from valve housings.
7. Remove roll pin from control button which releases the slide from control button.

NOTE: The above step should be performed only if the slide shows conditions of wear or scoring, which requires replacement of the slide.

Cleaning and Inspection

1. Clean all metal parts thoroughly, using a suitable cleaning fluid. Blow dry with air or wipe dry wity a clean lint-free cloth.
2. Check all the parts for wear, distortion, cracks, or other damage.
3. Replace all parts that would affect proper operation of the control valve.

IMPORTANT: Be sure to use new O-rings which are available in a service kit, when reassembling the valve. Also, the O-rings and the surfaces that operate against them are to be lubricated, SPARINGLY, with silicone fluid lubricant prior to assembly.

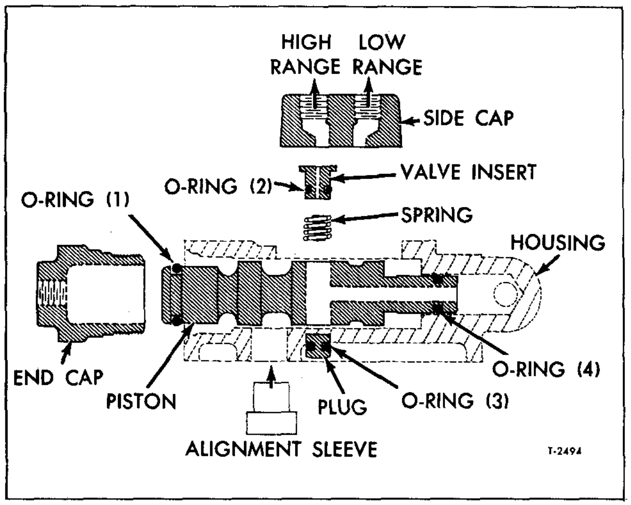


Figure 13—Air Valve

Assembly (Refer to Fig. 12)

1. Place the O-ring, valve plate, felt seal, position spring, and position ball in the rear housing.
2. Install O-ring on the valve insert.
3. Place the wave washer, valve insert, felt seal, position spring, and position ball in the front housing.
4. Position the slide in the control button and install roll pin (if removed).
5. Position the control button and slide assembly on the rear housing.

NOTE: It is most important that the slot at the lower end of the slide faces the OUTLET on the rear housing.

6. Carefully bring the front and rear housings together and install housing attaching parts. Tighten nuts firmly.

Installation (Refer to Fig. 8)

1. Place control valve and mounting clamp on gearshift lever.
2. Install the gearshift lever knob.
3. Position the control valve and mounting clamp so that the control button is 3 inches below the bottom of the gearshift lever grip. Tighten clamp securely.
4. Remove protective caps from nylon air lines. Connect the black air line to the outlet port of the control valve and connect the white air line to the inlet port.
5. Pressurize air system and check for leaks (correct as necessary).
6. Road test vehicle and check for proper range shifts.

AIR VALVE

Removal (Refer to Fig. 8)

1. Disconnect all air lines from the air valve.

NOTE: Be sure to place protective caps over the ends of the air lines to prevent entry of dirt or other foreign material.

2. Remove cap screws retaining air valve and gasket to adapter plate.

NOTE: Air valve is mounted on a special adapter plate which is attached to transmission case.

3. Remove alignment sleeve shown in figure 13.
4. Remove actuating pin and spring from bore in adapter plate.
5. Remove attaching parts retaining adapter plate and gasket to transmission (if necessary).
6. If necessary, remove fittings from air valve.

Disassembly

Key numbers in text refer to figure 13.

1. Remove attaching parts retaining side cap to valve housing.
2. Remove valve insert from piston and remove O-ring (2) from the valve insert.
3. Remove the spring from piston.
4. Remove end cap from housing and withdraw piston from housing bore.
5. Remove O-rings (1 and 4) from piston.
6. Remove nylon plug from piston and remove O-ring (3) from plug.

Cleaning and Inspection

1. Clean all metal parts thoroughly, using a suitable cleaning fluid. Blow dry with air or wipe dry with a clean lint-free cloth.
2. Check all parts for wear, cracks, distortion, or other damage.
3. Replace all parts that would affect proper operation of the control valve.

IMPORTANT: Be sure to use new O-rings which are available in a service kit, when reassembling the valve. Also the O-rings and the surfaces that operate against them are to be lubricated sparingly with silicone fluid lubricant prior to assembly.

Assembly (Refer to Fig. 13)

1. Install new O-rings on valve insert, piston, and plug.
2. Position plug in piston and insert piston in housing bore. Install end cap on housing. Tighten end cap, securely.
3. Position spring and valve insert in the piston. Install the side cap on housing. Tighten attaching parts securely.

Installation (Refer to Fig. 8)

1. Install fittings on air valve (if removed).
2. Install new gasket and adapter plate on transmission case. Use gasket cement SPARINGLY

when mounting gasket to transmission. Tighten attaching parts to 15 to 20 foot-pounds torque.

IMPORTANT: Use the alignment sleeve shown in figure 11 to check the alignment of the adapter plate to the transmission case. Readjust adapter plate if necessary to provide proper alignment.

3. Install the actuating pin and spring in the bore of the adapter plate.
4. Install the alignment sleeve in bore of air valve.

IMPORTANT: Before installing the alignment sleeve, check the bore in which it is to be installed to make sure the piston in the air valve is either in the forward or rearward position.

5. Install the air valve and gasket on the adapter plate. Use gasket cement SPARINGLY when mounting gasket on the adapter plate. Tighten cap screws to 15 to 20 foot-pounds torque.
6. Reconnect all air lines to air valve.
7. Pressurize air system and check for leaks and proper operation of the range shift system (correct as necessary).

REGULATOR VALVE

Removal (Refer to Fig. 8)

1. Disconnect air lines from regulator valve and air filter.
2. Remove cap screws retaining the regulator valve and air filter bracket to the transmission case.
3. Remove the large hexagonal nut from the regulator valve.
4. Unscrew the regulator valve from nipple mounted between regulator and air filter.

Disassembly (Refer to Fig. 14)

1. Mount the regulator valve in a vise (end-to-end) and tighten the vise lightly, to bring a slight pressure against the body and end cap.
2. Loosen large lock ring which attached end cap to body.
3. Slowly loosen vise, releasing the pressure exerted by the pressure spring. Remove parts from end cap of regulator.
4. Remove the diaphragm and piston plate from body of regulator.
5. Remove snap ring, washer and piston spring from the piston.
6. Push the piston out through the input port of the regulator.
7. Remove seal from piston bore of the body.

Cleaning and Inspection

1. Clean all metal parts thoroughly, using a suitable cleaning fluid. Blow dry with air or wipe dry with a clean lint-free cloth.

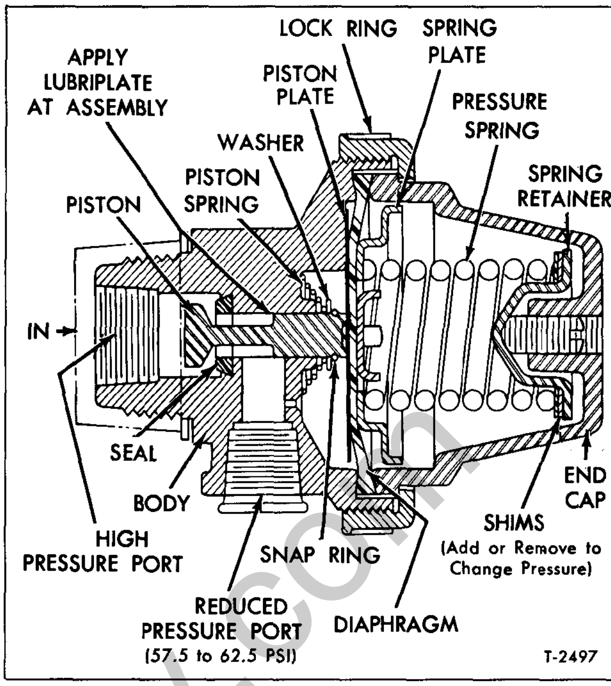


Figure 14—Regulator Valve

2. Check all parts for wear, cracks, distortion, or other damage. Replace all parts that would affect proper operation of the regulator valve.

IMPORTANT: When reassembling the regulator valve, be sure to use the regulator valve service kit which contains the following new parts: Seal, piston spring, diaphragm, snap ring, and two shims. The new shims should be used only if an increase in the air pressure setting of the regulator valve is required to reach the normal output range of 57.5 to 62.5 psi.

Assembly (Refer to Fig. 14)

1. Install new seal in regulator valve body.
2. Apply Lubriplate sparingly to that portion of the piston that comes in contact with the body bore. Insert piston into body bore.
3. Install piston spring, washer, and snap ring.
4. Install spring retainer, shims, pressure spring and spring plate in the end cap.

IMPORTANT: The number of shims between the pressure spring and spring retainer should not be changed, if the outlet pressure of the regulator valve was 57.5 to 62.5 psi, prior to disassembly.

If, after cleaning the regulator and replacing worn parts, the regulator still does not read within limits (57.5 to 62.5 psi), pressure setting can be changed by the addition or removal of shims.

a. Add shims to raise air pressure.

b. Remove shims to lower air pressure. One shim is equal to approximately 2 psi.

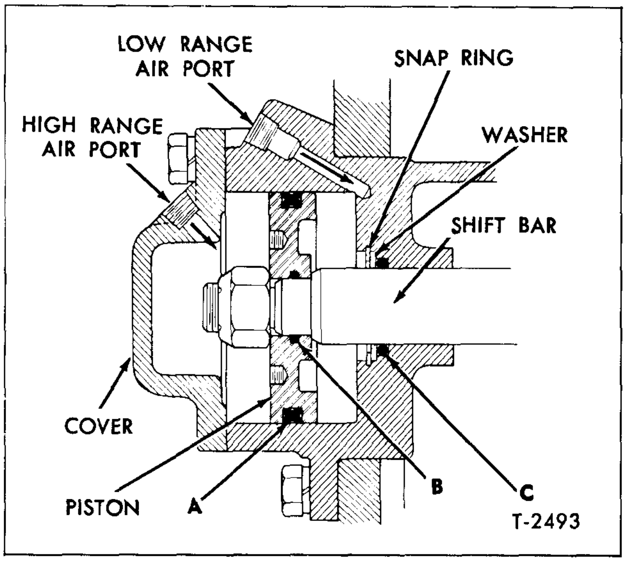


Figure 15—Range Shift Cylinder Seal Location

5. Install the attaching parts retaining the diaphragm to the piston plate. Insert piston plate and diaphragm assembly into the regulator body.

6. Mount the body and end cap assemblies in a vise. Tighten lock ring firmly.

Installation (Refer to Fig. 8)

1. Attach regulator valve to the nipple protruding from air filter.

2. Tighten the large hexagonal nut retaining the regulator valve to the support bracket (not shown).

3. Connect an air pressure gauge to the outlet port of the regulator valve. Remount regulator and air filter bracket on the transmission case.

4. Reconnect air lines to the air filter and regulator valve.

5. Pressurize the air system, then check for leaks (correct as necessary).

NOTE: Check the reading on the air pressure gauge which should be 57.5 to 62.5 psi. If the reading does not correspond to this figure, add or remove shims to the regulator as described previously under "Regulator Valve Assembly."

6. Remove pressure gauge and reconnect air line to outlet port of regulator valve.

RANGE SHIFT CYLINDER SEAL REPLACEMENT (Refer to Fig. 15)

1. Remove air lines from shift cylinder.

NOTE: Be sure to place protective caps over the ends of the air lines to prevent entry of dirt or other foreign material into the air system.

2. Remove cover from shift cylinder.

3. Remove elastic stop nut retaining piston to shift bar.

4. Apply LIGHT amount of air pressure at low range air port to remove piston.

CAUTION: When using air pressure to remove piston, do not stand in front of range shift cylinder during removal.

5. Remove seals ("A" and "B") from piston and replace with new seals.

NOTE: Seal "C" is to be replaced at transmission overhaul.

6. Make sure shift cylinder bore is clean. Insert piston into cylinder bore with flat side of piston facing out.

7. Install elastic stop nut on shift bar. Tighten nut to 80-90 foot-pounds torque.

8. Install cover and gasket on the range shift cylinder. Use gasket cement SPARINGLY when mounting gasket on the shift cylinder. Tighten cap screws to 35-45 foot-pounds torque.

NOTE: Cover is installed with high range air port facing upper left portion of range shift cylinder.

9. Connect air lines to shift cylinder and check for air leaks.

SPLITTER CONTROL VALVE (Refer to Fig. 16)

Porting

There are four ports in bottom of the control:

1. The port stamped "S" is the supply port and is the constant air line from the cross on range air valve.

2. The port stamped "D" is the delivery port and is connected to the shift cylinder cover center port.

3. The port stamped "E" is the exhaust port and is left open.

4. The unmarked port is a blind port and not used.

Fittings

All splitter control air lines are 1/8" O.D., 0.178" I.D. nylon tubing. The two connectors are 1/16" pipe thread; they are not interchangeable with the range shift control fittings which are 1/8" pipe thread.

Operation

The splitter control valve is an "OFF-ON" air switch.

1. With lever in "DIRECT" the valve is closed. Air in the line to the splitter shift cylinder cover exhausts through the control valve when lever is moved from "OVERDRIVE" to "DIRECT."

2. With the lever in "OVERDRIVE" the control valve is open and air passes through to the shift cylinder cover.

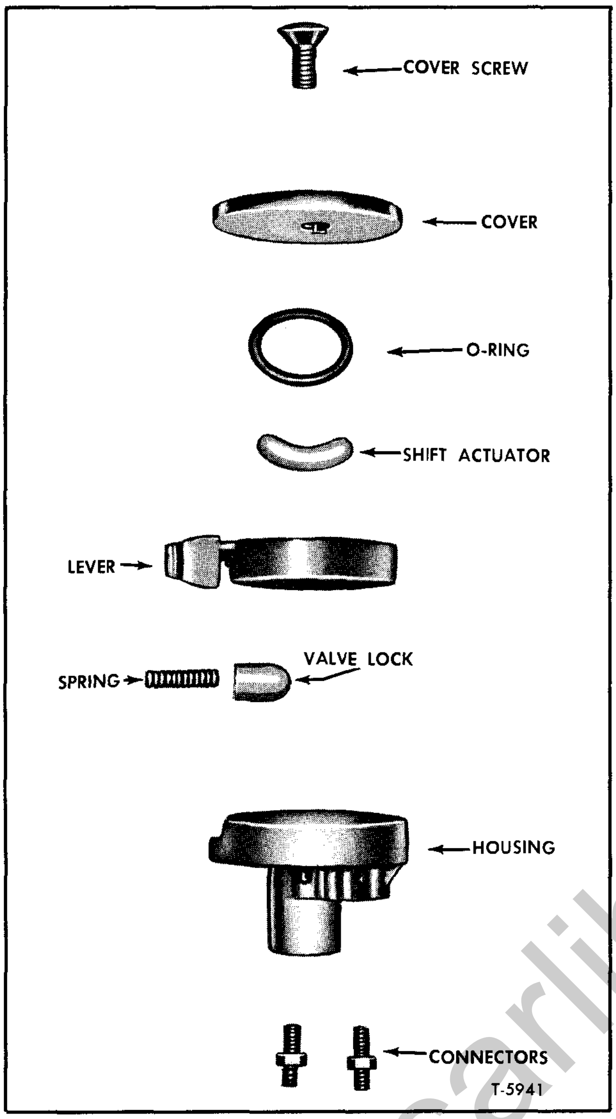


Figure 16—Splitter Control Valve

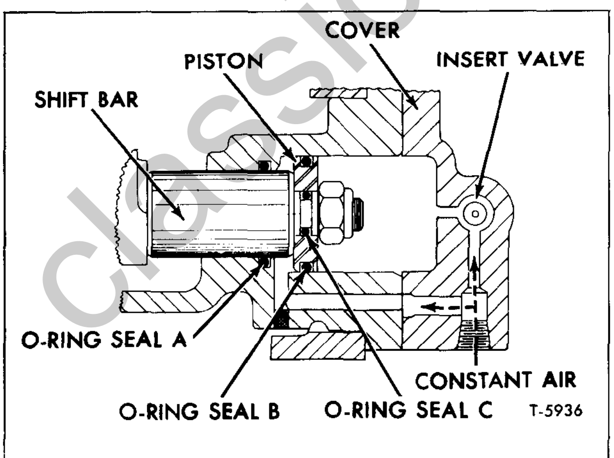


Figure 17—Splitter Shift Cylinder

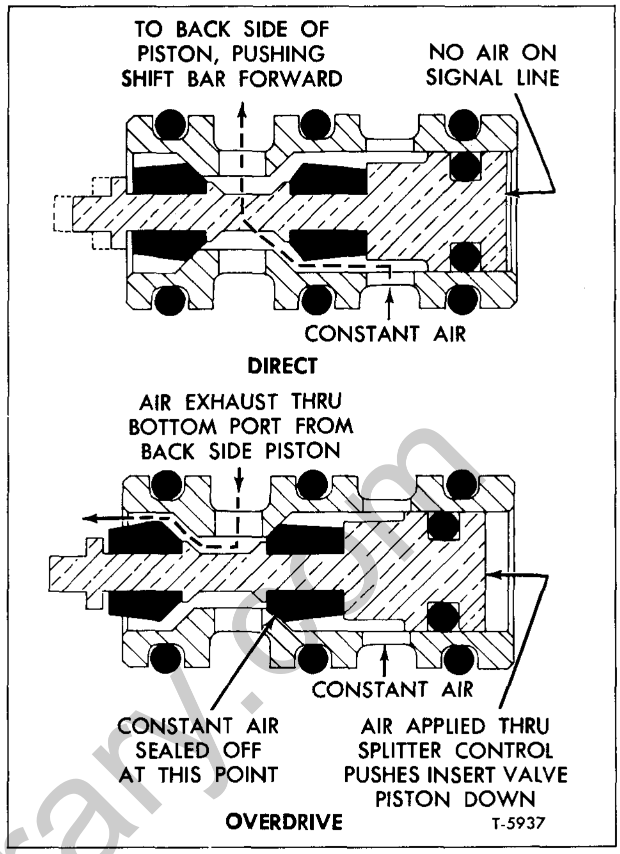


Figure 18—Insert Valve

Maintenance and Assembly

The splitter control valve is easily disassembled by removing the top plate screw. Individual parts can be obtained in a kit.

1. Make sure jam nut locking control valve to the gearshift lever is secure.
2. Make sure that top plate screw is torqued with 90 to 120 inch-pounds. A loose top plate screw can affect valve operation.
3. When assembling, lubricate O-ring and O-ring carrier with a barium base grease.

SPLITTER SHIFT CYLINDER
(Refer to Fig. 17)

Porting

Constant, regulated air is supplied to the side port of cylinder cover through a ¼" I.D. air line from the tee on regulator.

The center port in cover is connected to the "D" or delivery port in the splitter control through a 1/8" O.D., 0.078" I.D. nylon air line.

Operation

Constant, regulated air is channeled through the cover to the front side of shift piston - air is always on this side of piston.

The shift piston is moved by removing or applying air (from constant supply) to the back-side of piston. This piston area is larger and can overcome area of front side of piston. The removal or application of air on backside of piston is controlled by the insert valve in cylinder cover; this valve in turn is controlled by the splitter control valve.

INSERT VALVE (Refer to Fig. 18)

The insert valve located in the shift cylinder cover is a small 1-3/16" Humphrey valve. It is installed with the flat surface to the inside towards the center port, and it is secured with a special nut in bottom bore of cover.

When installing insert valve apply Dow Corning #200 Lubricant or its equivalent to cylinder walls. When installing special nut apply Loctite hydraulic sealant to threads.

The insert valve is self-contained and cannot be disassembled except for the three O-rings on outer diameter. These three O-rings are a stationary seal and do not move in cylinder.

Travel of the small piston in insert valve is only 3/16". The insert valve is a normally-open valve. Thus, when there is no signal or delivery of air to topside of insert piston, the constant air from regulator passes through the insert valve and to the backside of the piston and moves the shift bar forward ("DIRECT").

When the insert valve piston is activated by a signal or delivery of air, the insert valve is closed and shuts off the constant air to backside of shift piston. Air in shift cylinder is exhausted out through insert valve and bottom bore of cover.

When air is removed from backside of shift piston, constant air on front side of shift piston moves the shift bar to the rear ("OVERDRIVE").

AUXILIARY TRANSMISSIONS

(SPICER MODELS 6041, 7041, 8341F, AND 8345F)

This section covers on-vehicle service information on Spicer Auxiliary Transmissions. Gear shifting is accomplished by use of the shift lever in the cab, which is interconnected to the auxiliary transmission with cables or rods. The auxiliary transmission is supported at the front by a support bracket attached to frame side rails and at the rear by a support beam attached to frame brackets. Hand brake (when used) and speedometer drive are at rear of transmission.

LINKAGE ADJUSTMENT

ROD TYPE LINKAGE ADJUSTMENT (Refer to Fig. 1)

1. Disconnect control rods from shift control tower under cab.
2. Place the auxiliary transmission gearshift lever and shift rods on the transmission in "NEUTRAL."

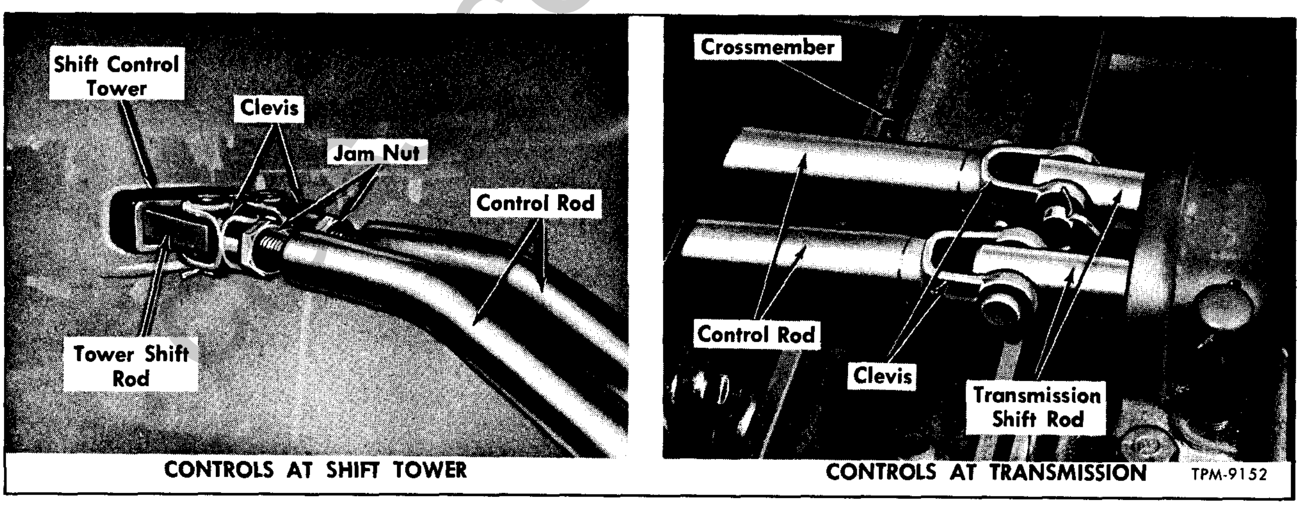


Figure 1—Rod Type Auxiliary Transmission Linkage

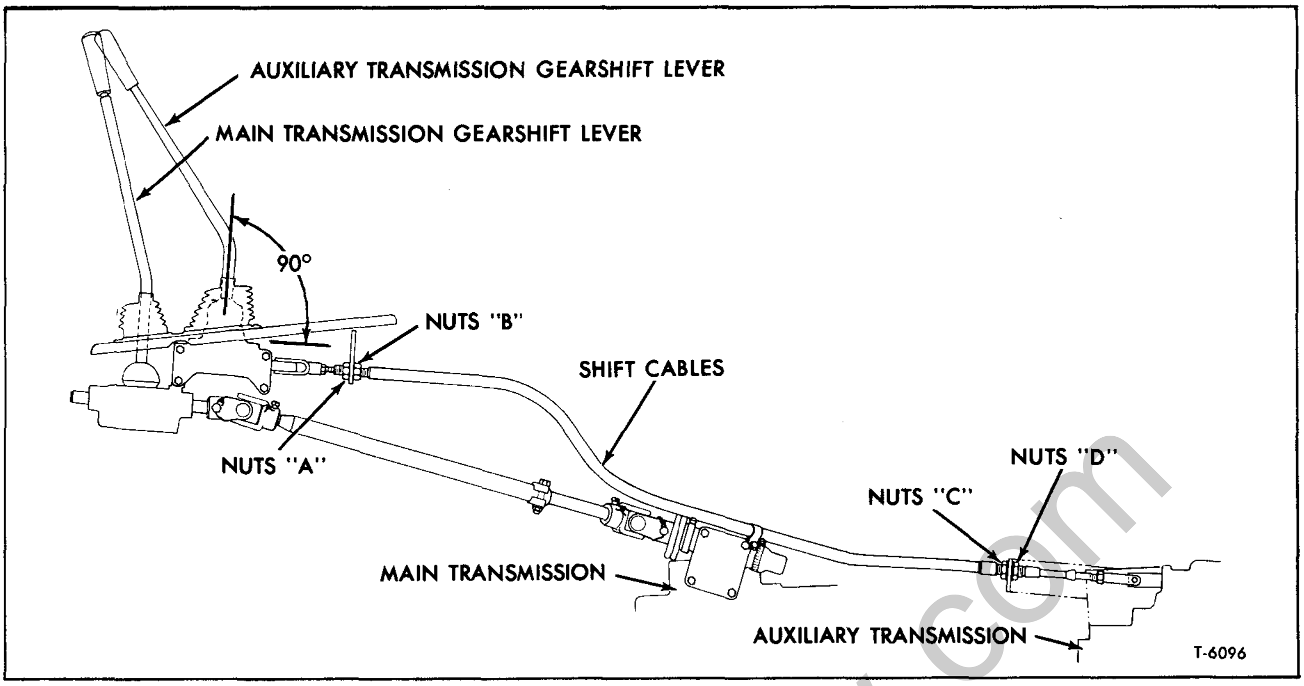


Figure 2—Cable Type Auxiliary Transmission Linkage

3. Adjust the length of each control rod by rotating its adjustable clevis to provide a free clevis pin fit.

4. Reconnect control rods to the shift control tower and shift transmission through entire shift pattern.

NOTE: At the extreme control rod movements, clevis pins should rotate freely. Readjust linkage if necessary to obtain these conditions. Replace any worn or damaged cotter pins. Tighten lock nuts firmly.

5. Lubricate control linkage as described in LUBRICATION (SEC. 0) of this manual.

CABLE TYPE LINKAGE ADJUSTMENT
(Refer to Fig. 2)

Perform the following with cab tilted:

1. Position shift rods on auxiliary transmission in middle poppet position (Neutral).

2. With the gearshift lever held perpendicular (90 degrees) to the control island shift mechanism as shown, by an assistant, adjust the length of each shift cable to retain the above mentioned conditions.

NOTE: Adjustment at control island is made by repositioning NUTS "A" and NUTS "B" as required. Adjustment may also be made at the auxiliary transmission by repositioning NUTS "C" and NUTS "D" as necessary.

3. Check adjustment by moving gearshift lever through the shift pattern. There must be no binding in the linkage.

NOTE: Due to the construction of internal components in the transmission it may be necessary to road test the vehicle to check the entire shift pattern. At the extreme shift cable movements, clevis pins should rotate freely. Readjust linkage if necessary to obtain these conditions.

5. Replace any worn or damaged cotter pins.

AUXILIARY TRANSMISSION REPLACEMENT

REMOVAL

1. Drain lubricant from auxiliary transmission.

2. Disconnect propeller shafts from input and output ends of transmission. Refer to "PROPELLER SHAFTS" (SEC. 4D) in this manual.

NOTE: Support propeller shafts securely, to prevent damage from dropping.

3. Disconnect shift control rods or cables from the front of the transmission.

4. Disconnect speedometer cable from adapter at rear of the transmission.

NOTE: Some models have the speedometer drive mounted on the front axle instead of at rear of transmission.

5. Disconnect parking brake linkage (when used).

6. Remove all connections to the auxiliary transmission power take-off (when used).

7. Position a suitable dolly or jack under the

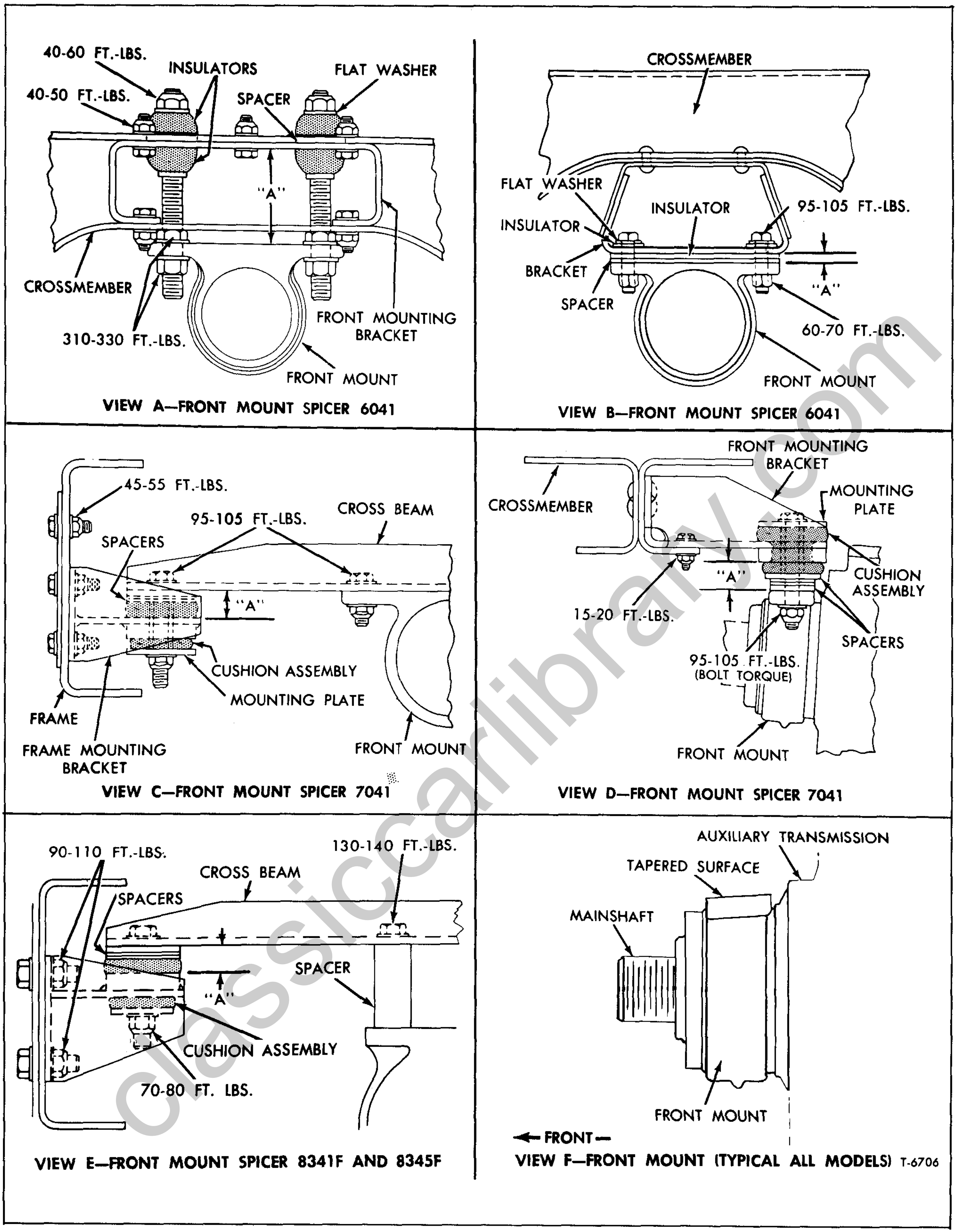


Figure 3—Auxiliary Transmission Front Mountings

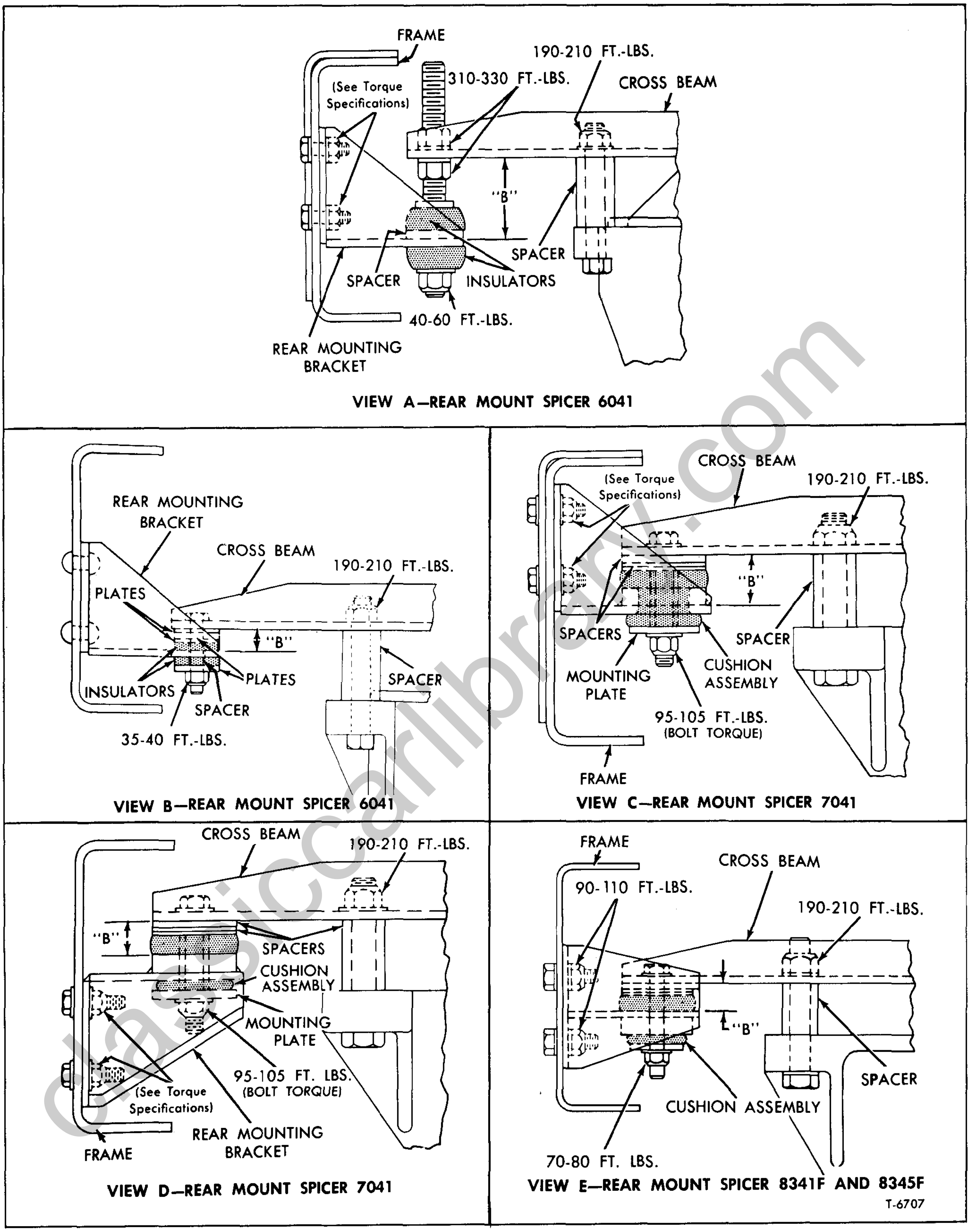


Figure 4—Auxiliary Transmission Rear Mountings

transmission and adjust to safely carry the weight of the transmission.

8. Remove attaching parts from auxiliary transmission front and rear mountings. Lower transmission away from the chassis.

INSTALLATION (Refer to Figs. 3 and 4)

The procedures required to install auxiliary transmission are dependent on the type of transmission mountings which vary due to different vehicle driveline configurations.

1. Be sure the tapered surface of the auxiliary transmission front mount faces the front of the vehicle as shown in View F, figure 3.

2. With transmission mounted on a suitable dolly or jack move into position under the vehicle. Adjust front and rear height as listed in "Auxiliary Transmission Application and Alignment Data" chart.

3. Tighten attaching parts to proper specifications as shown in figures 3 and 4.

NOTE: For proper torque on frame-to-rear mounting bracket attaching parts (if removed) refer to torque specifications.

4. Reconnect propeller shafts to the input and output ends of the transmission as described in "PROPELLER SHAFTS" (SEC. 4D) in this manual.

IMPORTANT: The preceding steps, serve to locate the auxiliary transmission in relation to the vehicle's frame. Also, it is essential that the auxiliary transmission be checked for proper driveline angle adjustment as described under "PROPELLER SHAFTS" (SEC. 4D) in this manual.

5. Reconnect power take-off (when used).

6. Reconnect parking brake linkage (when used).

7. Connect speedometer cable to adapter at the rear of the transmission.

8. Reconnect shift control rods or cables to the front of the transmission and adjust linkage if necessary.

9. Refill transmission with lubricant recommended in LUBRICATION (SEC. 0) in this manual.

TORQUE SPECIFICATIONS

Location	Size	Length	Nut Torque (Ft.-Lbs.)
Frame-to-Rear Mounting	1/2"-20	1-3/4"	30-40
Bracket Bolt	1/2"-20	1-7/8"	45-55
	5/8"-18	2"	90-110

AUXILIARY TRANSMISSION APPLICATION AND ALIGNMENT DATA CHART (USE IN CONJUNCTION WITH FIGURES 3 AND 4)

TRUCK MODELS	ENGINE	MAIN TRANS-MISSION	AUXILIARY TRANS-MISSION	FRONT MOUNTING (FIGURE 3)	DIMEN-SION "A" INCHES	REAR MOUNTING (FIGURE 4)	DIMEN-SION "B" INCHES
JM80	401M	SP5652	SP6041	View A	$4\frac{5}{16}$	View A	$3\frac{1}{2}$
JM70	401M	SP5652	SP6041	View A	$4\frac{5}{8}$	View A	$3\frac{3}{8}$
JM70	478M	CL401V	SP7041	View D	$1\frac{1}{8}$	View C	$1\frac{1}{8}$
JV80	6V-53	CL385V	SP7041	View C	$1\frac{3}{16}$	View D	$1\frac{3}{16}$
JV70	6V-53	CL385V	SP7041	View D	$1\frac{3}{16}$	View C	$1\frac{3}{16}$
JN90	NHC-250	SP8552	SP8341	View E	$1\frac{1}{8}$	View E	$1\frac{1}{8}$
DH90	8V-71	SP8552	SP8341	View E	$1\frac{1}{8}$	View E	$1\frac{1}{8}$
DH90	8V-71	SP8554	SP8345	View E	$1\frac{1}{8}$	View E	$1\frac{1}{8}$

CLUTCH CONTROLS

All Series 90 alum. tilt and conventional cab models (with vacuum brakes) covered by this manual are equipped with mechanically actuated clutch controls. All remaining models are equipped with hydraulically-actuated clutch controls. For servicing of either mechanical or hydraulically-actuated clutch controls refer to appropriate procedures following:

MECHANICAL LINKAGE CONTROLS

LINKAGE ADJUSTMENTS

HM, JM80 WITH VACUUM BRAKES
(Refer to Fig. 1)

1. Disconnect the release fork pull-back spring.
2. Move the release fork to a position where the release bearing can be felt to just barely contact the clutch release fingers.
3. Referring to the Inset, Figure 1, loosen lock nut. Adjust clearance between wedge and adjusting nut to ½-inch. Then tighten lock nut so as to maintain the ½-inch clearance between wedge and adjusting nut.
4. Connect pull-back spring to the release fork, then check operation of clutch linkage.

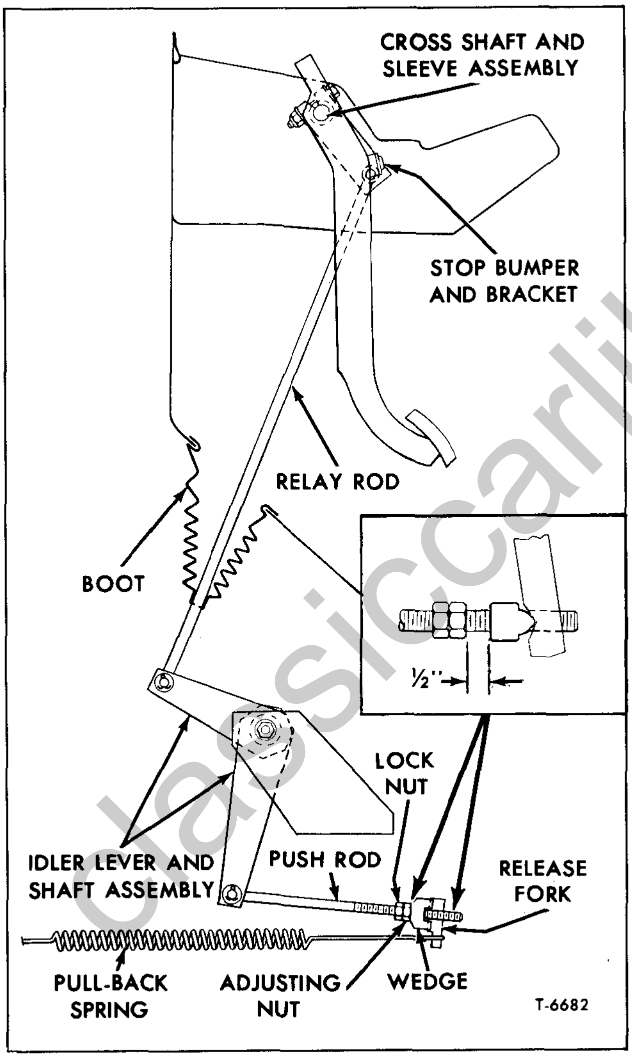


Figure 1—Mechanical Clutch Linkage (HM, JM 80)

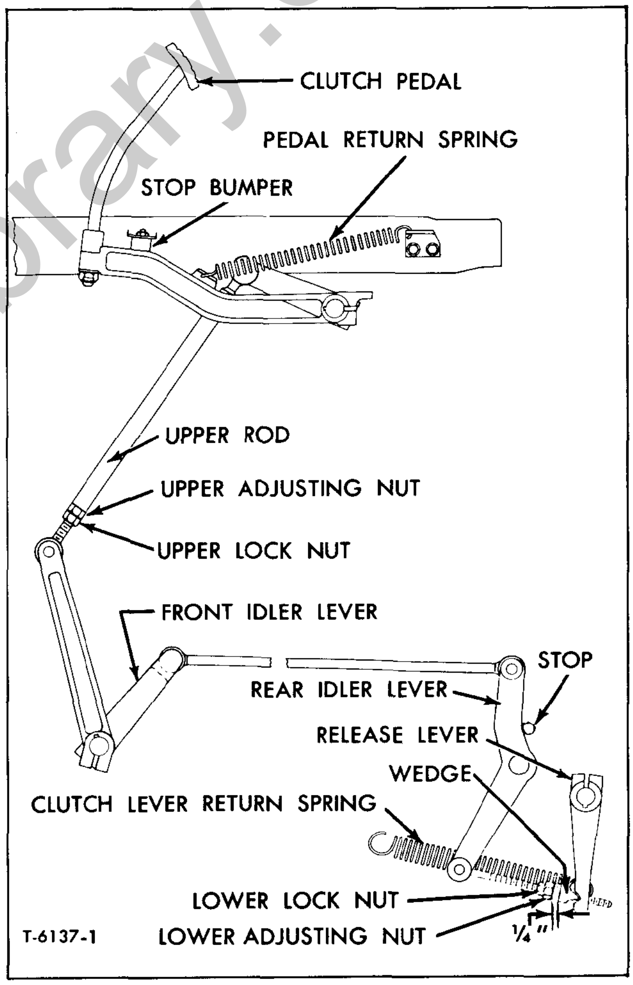


Figure 2—Series 90 Alum. Tilt Clutch Linkage (Equipped with Lipe-Rollway Clutch)

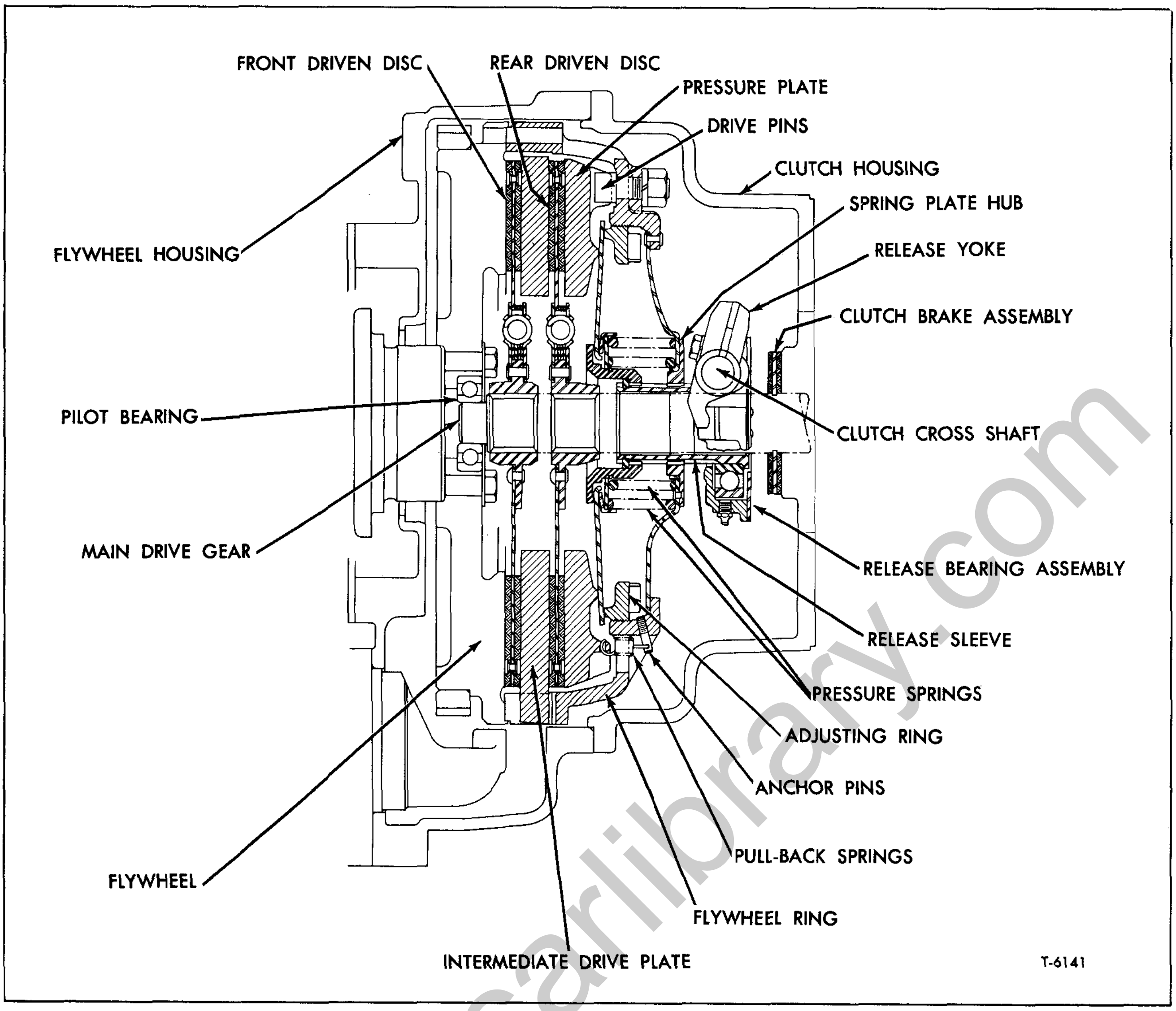


Figure 3—Spicer Clutch (Typical)

SERIES 90 EQUIPPED WITH LIPE-ROLLWAY 14-INCH DUAL DISC CLUTCH (Refer to Fig. 2)

1. Block clutch pedal in fully engaged position (against stop bumper) and hold rear idler lever against stop (as shown).
2. Rotate upper adjusting nut until it contacts upper rod. Tighten upper lock nut against upper adjusting nut.
3. Disconnect clutch lever return spring from release lever.
4. Loosen lower lock nut. Adjust position of lower adjusting nut to provide 1/4-inch clearance between wedge and adjusting nut, with the release lever held rearward until the release bearing is just contacting the release fingers.
5. Tighten lower lock nut against lower adjusting nut and connect clutch lever return spring. Remove block from clutch pedal.

SERIES 90 ALUM. TILT EQUIPPED WITH SPICER 14-INCH OR 15-1/2-INCH DUAL DISC CLUTCH

Following is a brief explanation why this clutch must be adjusted internally:

CAUTION

DO NOT ADJUST THE EXTERNAL LINKAGE OF THE SPICER 15½-INCH CLUTCH TO COMPENSATE FOR WEAR. THE EXTERNAL LINKAGE SHOULD ONLY BE RESET TO PROVIDE PROPER FREE-TRAVEL AFTER THE INTERNAL CLUTCH ADJUSTMENT HAS BEEN MADE.

Most maintenance personnel use the clutch pedal "free-travel" or "free-pedal" movement as

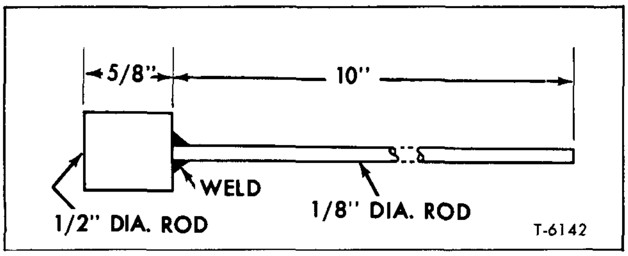


Figure 4—Improvised Release Bearing Clearance Checking Tool

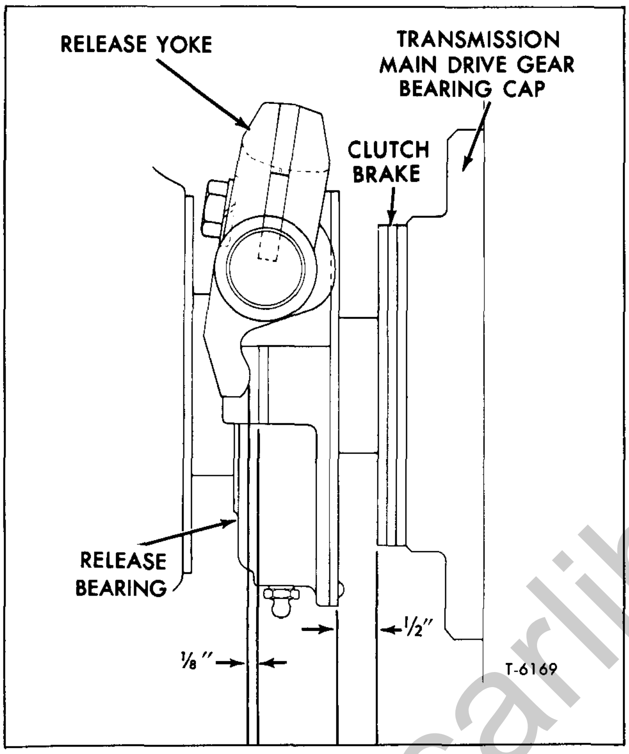


Figure 5—Release Bearing Clearance

their guide to conditions inside the clutch. The actual "free-travel" is easily determined if checked by hand and should represent release yoke fingers and release bearing housing. The proper clearance of 1/8-inch between the yoke and bearing housing which will correspond to approximately 1½ inches clutch "free-pedal" travel in the cab.

Whenever the "free-pedal" travel falls below ½-inch the clutch should be adjusted internally. If the free-pedal travel is not restored to approximately 1½ inches travel and proper clutch brake squeeze obtained, the readjustment of external linkage may be necessary.

It is important that technicians actually check for release yoke movement to verify that "free-pedal" travel in the cab is actually release bearing clearance and not lost motion in the linkage due to worn bushings, shafts, or linkage arms.

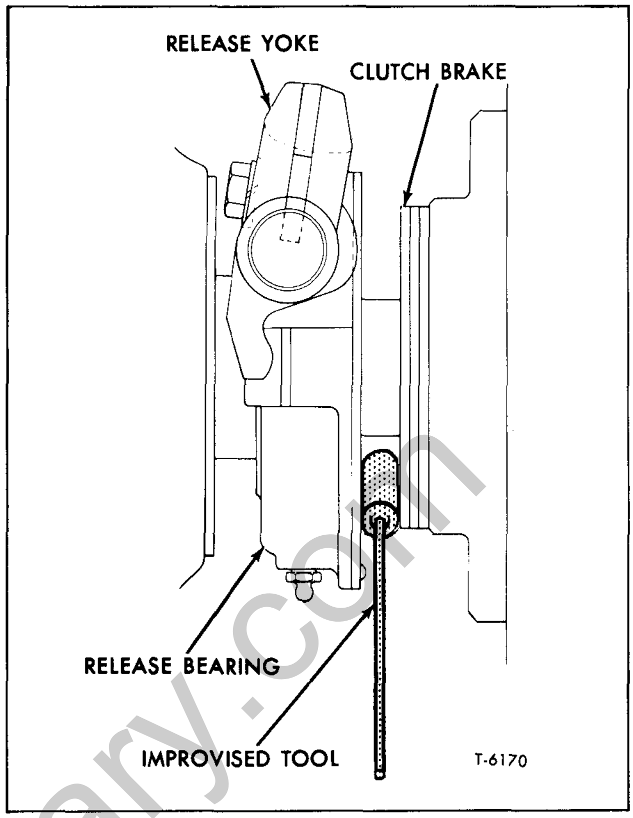


Figure 6—Checking Gap Between Release Bearing and Clutch Brake

When the clutch facings wear (fig. 3), the release bearing "moves in" toward the flywheel. Since yoke position is fixed, the inward movement of the release bearing assembly reduces the original 1/8-inch clearance between the release yoke and bearing. At the same time, the gap between release bearing assembly and clutch brake will increase over the ½-inch. When the clutch wears the driver will note a loss in "free-pedal." Rotating the internal adjusting ring (fig. 3) to move the release bearing back to its original position will restore proper "free-pedal" travel. Continuing to operate the vehicle without "free-pedal" will load the release bearing and possibly cause premature failure. If the clutch is allowed to operate without "free-pedal" it will start to slip since it is being held in a partially released position.

Internal Clutch Adjustment
(Refer to Fig. 3)

NOTE: A tool for checking clearances at the release bearing can be improvised locally. See figure 4 which shows dimensions of tool.

1. Remove inspection hole cover from lower portion of the clutch housing.

2. The clearance between release bearing and clutch brake for a properly adjusted clutch is ½-inch as shown in figure 5. Using large end of tool

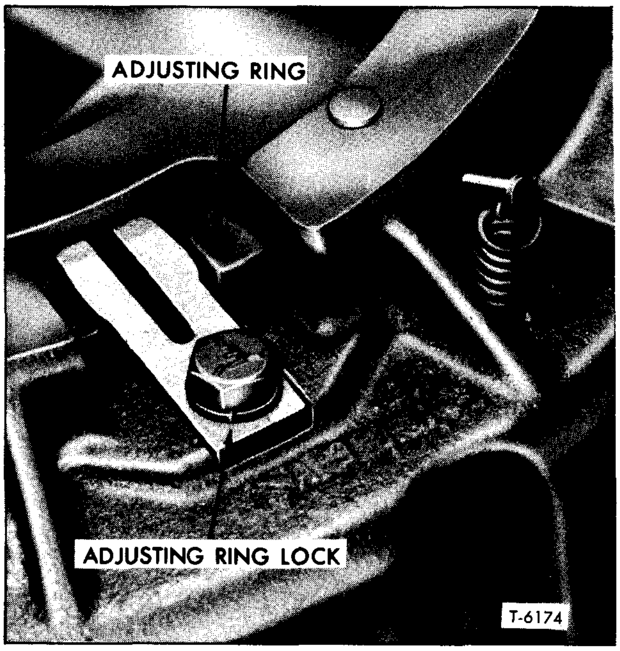


Figure 7—Adjusting Ring with Adjusting Ring Lock Installed

(as shown in figure 6) check clearance between release bearing and clutch brake. If clearance is more or less than recommended, readjust clutch as follows:

> CAUTION: TO PREVENT ACCIDENTAL STARTING PRIOR TO PERFORMING THE FOLLOWING STEP, BE SURE THE ENGINE STOP OR SHUT-OFF CONTROL KNOB IS IN THE "STOP" (UP) POSITION, TRANSMISSION GEARSHIFT LEVER IN NEUTRAL, AND THE VEHICLE'S WHEEL BLOCKED.

3. Rotate flywheel until the adjusting ring lock (fig. 7) is exposed at inspection hole opening in the bottom of clutch housing.
4. Referring to figure 7, remove cap screw and lock washer. Use screwdriver or similar wedge to pry adjusting ring lock free of the adjusting ring.

> CAUTION: Use care when removing adjusting ring lock because it is spring-loaded in the adjusting ring notches.

5. Block the clutch pedal (in cab) down in a fully released position to remove spring load from adjusting ring inside the clutch.
6. Use a large screwdriver to turn adjusting ring.

NOTE: Turn adjusting ring CLOCKWISE to remove release bearing OUT or away from flywheel. Turn adjusting ring COUNTERCLOCKWISE to move release bearing assembly IN or toward the flywheel.

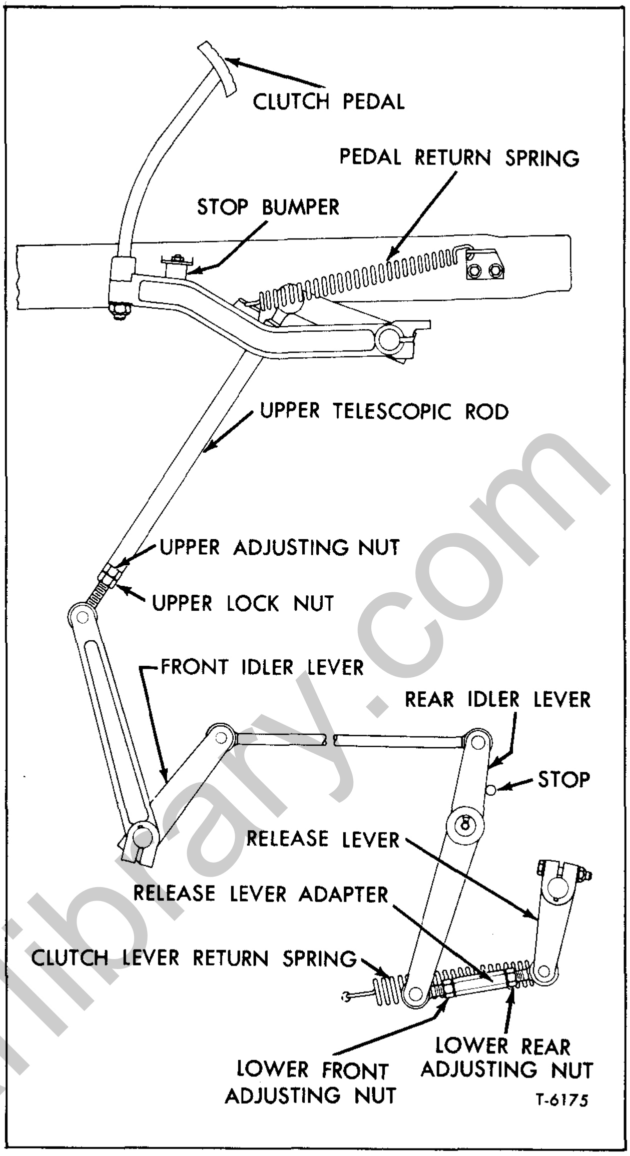


Figure 8—Series 90 Alum. Tilt Clutch Linkage (Equipped with Spicer Clutch)

IMPORTANT: Rotation or movement of one lug position on the adjusting ring will move the release bearing approximately 0.020-inch; that is, 3 x 0.020 = 0.060 or 1/16-inch. 5 x 0.020 = 0.100 or 3/32-inch.

7. Remove block from clutch pedal to engage clutch and cycle the pedal a few times.
8. Recheck clearance between release bearing and clutch brake as described in Step 2 and readjust if necessary.
9. When satisfied that internal clutch adjustment is correct, install adjusting ring lock.

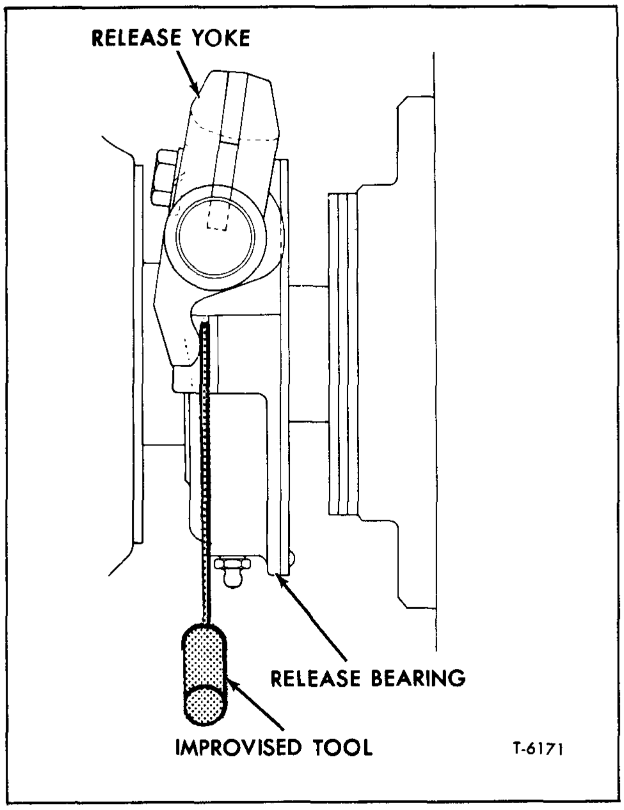


Figure 9—Checking Clearance Between Yoke and Release Bearing

IMPORTANT: Align adjusting ring notch with slot in clutch ring and tap ring lock into position. Install lock washer and cap screw.

External Linkage Adjustment
(Refer to Fig. 8)

NOTE: External linkage adjustment should be performed, if necessary, only after internal adjustment has been performed.

1. With cab in normal riding position (locked-down), block clutch pedal in fully engaged position (against stop bumper) and hold rear idler lever against stop (as shown).
2. Rotate upper adjusting nut until it contacts upper telescopic rod. Tighten upper lock nut against upper adjusting nut.

NOTE: While performing the following steps the rear idler lever must be held against STOP, as shown, and the clutch lever return spring disconnected from release lever.

3. Loosen lower-front adjusting nut (left-hand threads) and the lower-rear adjusting nut (right-hand threads).
4. The clearance between release bearing and yoke (free-travel) should be 1/8-inch as shown in figure 5. Using small end of improvised tool (fig. 4), check clearance between yoke and release bearing as shown in figure 9. If clearance is more or less than recommended, rotate release lever adapter, using a ¾-inch open end wrench, until gap between yoke and release bearing is 1/8-inch.
5. Connect clutch lever return spring and cycle the pedal a few times.

NOTE: While assistant is cycling pedal, check for yoke movement when pedal is depressed, to verify that "free-travel" in the cab is actually release bearing clearance and not lost motion in the linkage due to worn bushings, shafts, or linkage arms.

6. Recheck clearance between yoke and release bearing as described in Step 4 and readjust if necessary.
7. When satisfied that free-travel is correct, tighten both the lower front adjusting nut (left-hand threads) and the lower rear adjusting nut (right-hand threads).
8. Install inspection hole cover in lower portion of clutch housing.

HYDRAULIC TYPE CONTROLS

DESCRIPTION AND OPERATION

The clutch hydraulic control system for models covered by this manual is illustrated in figures 10, 11, and 12. This system utilizes hydraulic pressure as a means of transmitting clutch pedal movement to the clutch release mechanism. The system consists of a pedal-operated master cylinder and a slave cylinder, interconnected with hydraulic lines. Pedal is connected to the master cylinder push rod, and the slave cylinder push rod is connected to the clutch release fork or lever.

When the clutch pedal is depressed, hydraulic fluid is displaced from the master cylinder into the slave cylinder, forcing the slave cylinder piston outward. Movement of piston is transmitted through slave cylinder push rod and clutch release fork or lever, disengaging the clutch.

When pedal is released, pedal return spring returns pedal to released (clutch engaged) position. With pressure removed from hydraulic fluid, clutch engages. Slave cylinder push rod return spring forces push rod and piston rearward in slave cylinder, displacing hydraulic fluid back into the master cylinder. The above events occur with each clutch disengagement.

MAINTENANCE

To maintain proper clutch operation the system should be checked and serviced periodically as stated following:

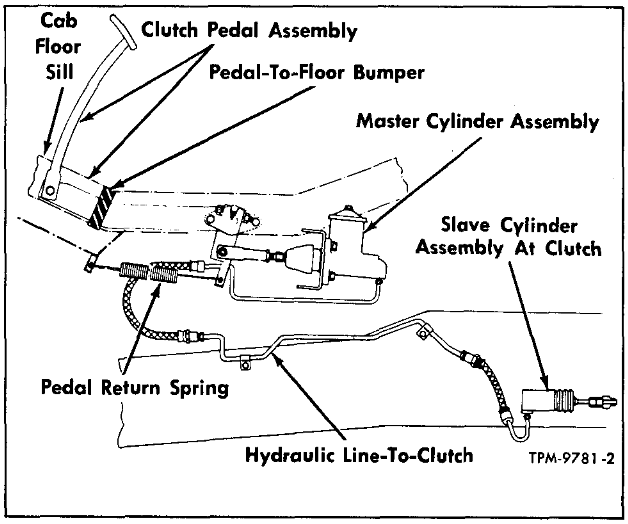


Figure 10—Typical Clutch Hydraulic System (TM 80 and TV 70)

1. Maintain proper level of hydraulic fluid in master cylinder. Refer to LUBRICATION (SEC. 0) in this manual for recommended fluid and checking intervals. At least once a year, drain and flush the entire clutch system and refill with new fluid.
2. Inspect entire clutch system regularly for fluid leakage. Leakage must be corrected immediately.
3. Make sure return spring at slave cylinder is not weak or broken.
4. Check and if necessary adjust clutch pedal linkage. Instructions are explained later under "Clutch Control Adjustments."
5. If clutch pedal action is springy or spongy, it is an indication that air needs to be bled from hydraulic system or adjustment is necessary.
6. Clutch release bearing, when equipped with grease cup, must be lubricated at regular intervals as directed in LUBRICATION (SEC. 0) in this manual

CLUTCH CONTROL ADJUSTMENTS

IMPORTANT: Procedures for adjusting the clutch controls on HN, JN90 when equipped with a Spicer clutch are found later in this section.

Adjustments are generally required due to wear of parts, or whenever the master cylinder, slave cylinder, or clutch assembly has been replaced.

To obtain proper clutch operation, two adjustments are required: Master cylinder push rod adjustment and the slave cylinder push rod adjustment.

NOTE: Master cylinder push rod adjustment is not required on steel tilt cab models, except TM80 and TV70.

Purpose of master cylinder push rod adjustment is to ensure full return of master cylinder

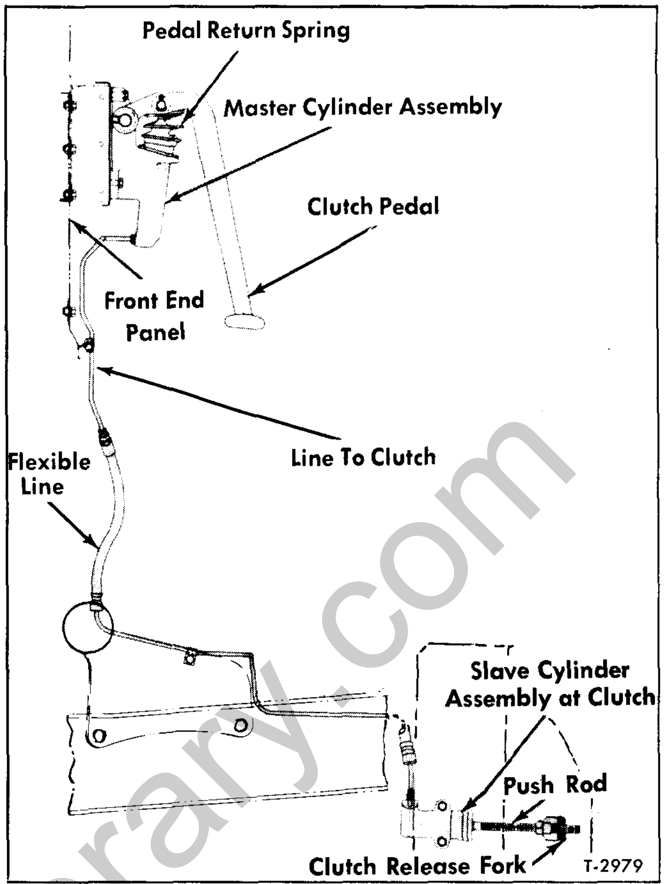


Figure 11—Clutch Hydraulic System (Steel Tilt Cab Models Except TM 80 and TV 70)

piston when foot is removed from pedal. If push rod is adjusted too long, piston could restrict the bypass port in cylinder, and clutch would not engage fully, thereby causing clutch to slip. Too short a push rod would result in excessive pedal free-travel before clutch starts to disengage.

Purpose of slave cylinder push rod adjustment is to provide proper position of clutch release bearing when the clutch is engaged.

Prior to making adjustments the hydraulic system must be free of air and the master cylinder must be filled to ½-inch below filler opening.

IMPORTANT: If clutch control adjustments are to be made, ALWAYS make adjustment at the master cylinder before making adjustment at the slave cylinder.

Access to the master cylinder on steel tilt cab models TM80 and TV70 is gained after removing small access door located at front of driver's seat riser as shown in figure 13. This master cylinder is bracket-mounted below the cab flooring as shown in figure 10. Access to pedal linkage for checking and adjusting purposes is

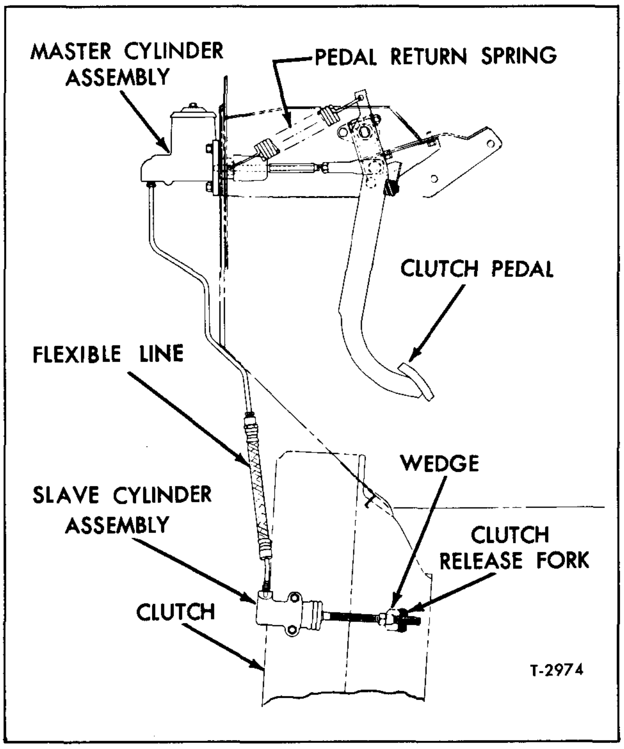


Figure 12—Clutch Hydraulic System (Typical for Conv. Cab Models)

made when the cab is tilted forward. However, when checking or replenishing fluid in the master cylinder, the cab must be in its lowered or operating position. Following servicing of hydraulic system examine door opening (fig. 13) or cover seal. Apply new caulking if necessary before installing door, otherwise dust may enter cab later at this location.

MASTER CYLINDER PUSH ROD
CHECK AND ADJUSTMENT

NOTE: This check and adjustment is not required on steel tilt cab models, except TM80 and TV70.

Before making adjustment, pull the master cylinder boot back on push rod. Visually check to see if the piston is seated firmly against piston snap ring in cylinder bore (fig. 14). If not, the push rod is too long and should be shortened, as directed later.

IMPORTANT: It is better to have push rod adjusted too short than for it to be too long. If the push rod is too long the clutch will not fully engage.

<u>All</u>

Loosen lock nut on master cylinder push rod assembly, then turn hex portion of push rod (fig. 15) as necessary to provide 0 to 1/16-inch clearance between push rod and master cylinder piston. After

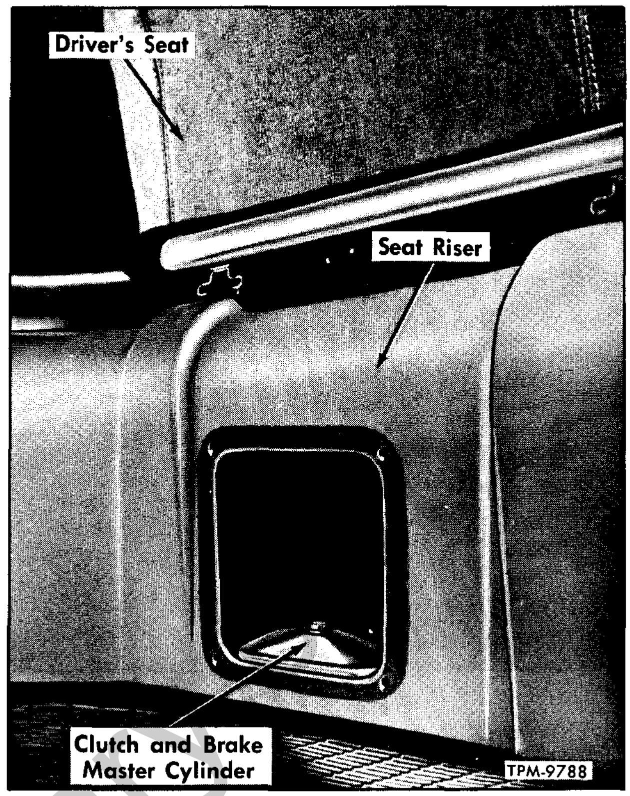


Figure 13—Master Cylinder Location (TM 80 and TV 70)

making adjustment, tighten lock nut on push rod.

IMPORTANT: Make sure piston contacts snap ring in master cylinder bore when pedal is released. Install boot on master cylinder.

IMPORTANT: Make sure piston contacts stop plate in master cylinder bore (fig. 26) when pedal is released. Install boot on master cylinder.

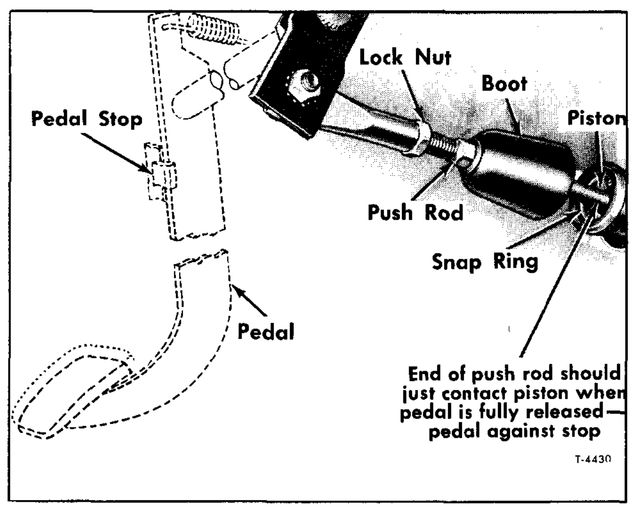


Figure 14—Master Cylinder Push Rod Check and Adjustment

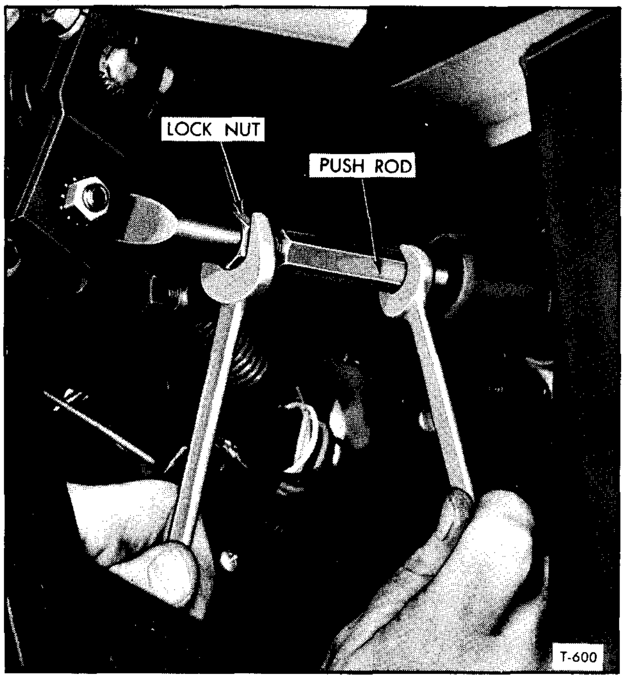


Figure 15—Adjusting Master Cylinder Push Rod

CLUTCH PEDAL STOP SCREW ADJUSTMENT

NOTE: Clutch pedal stop screw adjustment is required on all steel tilt cabs, except TM80 and TV70 models, which utilize a master cylinder mounted under the dash panel (fig. 15).

To provide complete and proper release of clutch on these vehicles, full travel of the clutch pedal must be assured. This is determined by the position of pedal stop screw which is located on cylinder body below the pedal.

The proper setting of stop screw is obtained when head of screw is just flush with surface of lock nut. After making adjustment tighten lock nut firmly.

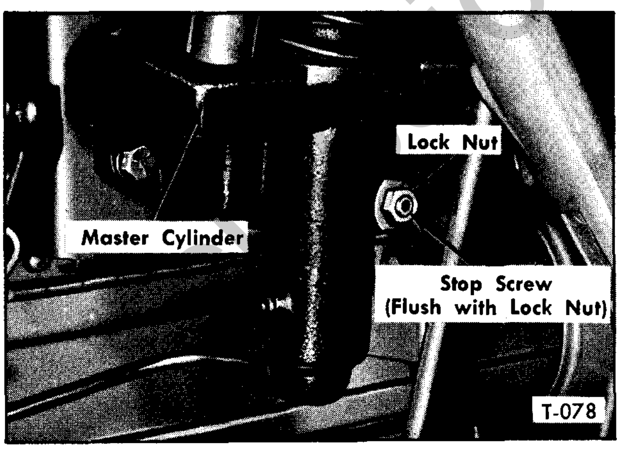


Fig. 16—Clutch Master Cylinder Installed (Steel Tilt Cab Models, Except TM 80 and TV 70)

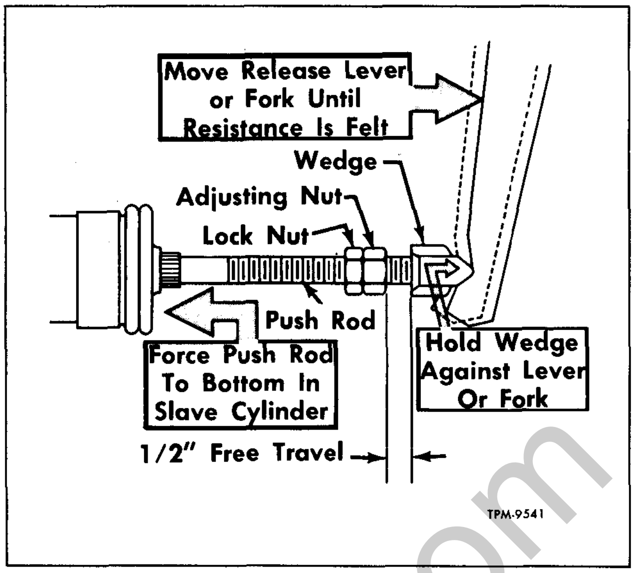


Figure 17—Slave Cylinder Push Rod Clearance (Except HN, JN 90 with Spicer Clutch)

NOTE: Regardless of clutch operation being obtained, the stop screw should be positioned as directed previously.

SLAVE CYLINDER PUSH ROD CHECK AND ADJUSTMENT

NOTE: This procedure does not apply to HN, JN90 with a Spicer clutch.

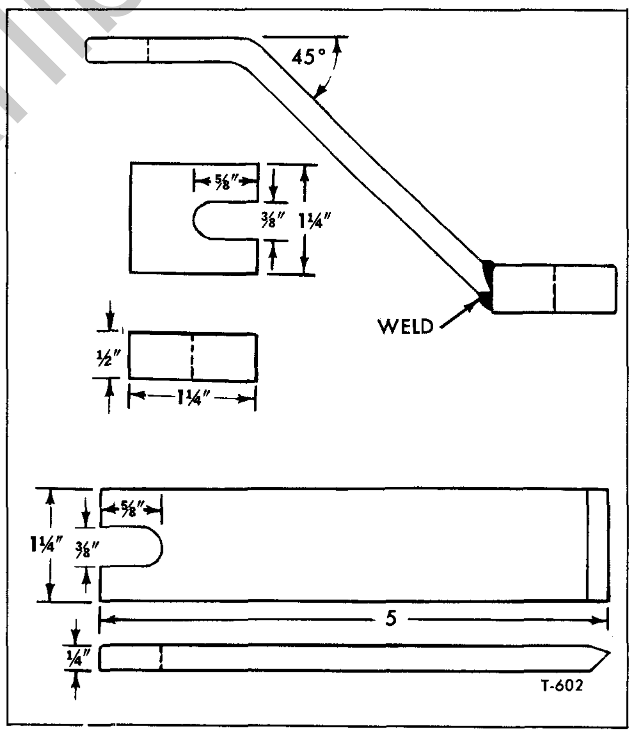


Figure 18—Push Rod Clearance Checking Tool

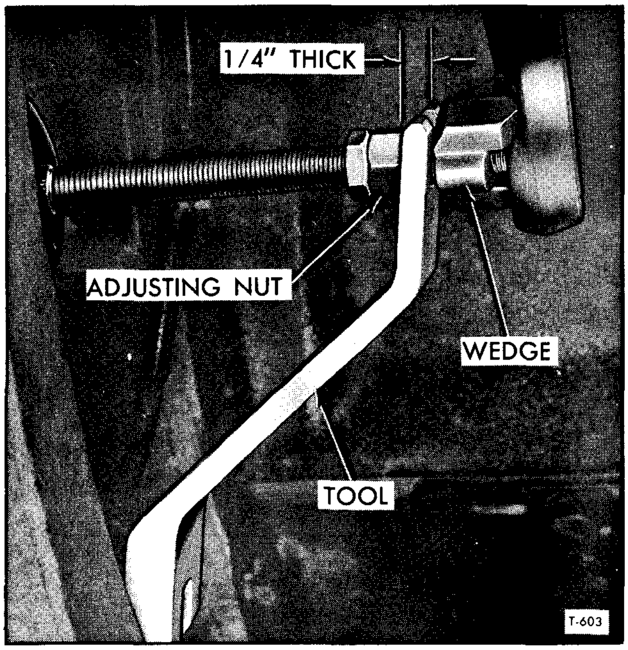


Figure 19—Checking Push Rod Clearance Using Small End of Tool

This procedure is generally required periodically to compensate for clutch facing wear. Purpose of adjustment is to maintain a definite clearance between the release bearing and the clutch release fingers with clutch engaged. See figure 17.

NOTE: A tool for checking clearance or the push rod nut position can be improvised locally. See figure 19 which shows dimensions of tool. A short ruler can be used to measure clearance if tool cannot be made available. Adjustment is necessary when this clearance at the wedge is reduced to or near ¼-inch. The proper clearance between wedge and adjusting nut should measure ½-inch.

The following describes adjustment procedure using special tool:

1. Disconnect the slave cylinder return spring.
2. With the push rod and piston seated in the slave cylinder, push clutch fork and wedge on push rod away from the slave cylinder. Insert smaller end of gauge on push rod between the adjusting nut and wedge (fig. 19). If the tool will not go between the nut and wedge the push rod needs to be adjusted. If the small tool end fits between the adjusting nut and wedge, the rod does not require adjustment.
3. To adjust the push rod, use the thicker end of the tool and insert between adjusting nut and wedge on the slave cylinder push rod (fig. 20). Back off adjusting nut until the tool just fits between the nut and wedge.
4. Remove the tool, lock adjusting nut with lock nut and install the slave cylinder return spring.

HN, JN90 EQUIPPED WITH SPICER 14-INCH OR 15½-INCH DUAL DISC CLUTCH

Following is a brief explanation why the Spicer clutch must be adjusted internally:

CAUTION

DO NOT ADJUST THE EXTERNAL LINKAGE OF THE SPICER 14- OR 15½-INCH CLUTCH TO COMPENSATE FOR WEAR. THE EXTERNAL LINKAGE SHOULD ONLY BE RESET TO PROVIDE PROPER FREE-TRAVEL AFTER THE INTERNAL CLUTCH ADJUSTMENT HAS BEEN MADE.

Most maintenance personnel use the clutch pedal "free-travel" or "free-pedal" movement as their guide to conditions inside the clutch. The actual "free-travel" is easily determined if checked by hand and should represent release yoke fingers and release bearing housing. The proper clearance of 1/8-inch between the yoke and bearing housing which will correspond to approximately 1½ inches clutch "free-pedal" travel in the cab.

Whenever the "free-pedal" travel falls below ½-inch the clutch should be adjusted internally. If the free-pedal travel is not restored to approximately 1½ inches travel and proper clutch brake squeeze obtained, the readjustment of external linkage may be necessary.

It is important that technicians actually check for release yoke movement to verify that "free-pedal" travel in the cab is actually release bearing clearance and not lost motion in the linkage due to worn bushings, shafts, or linkage arms.

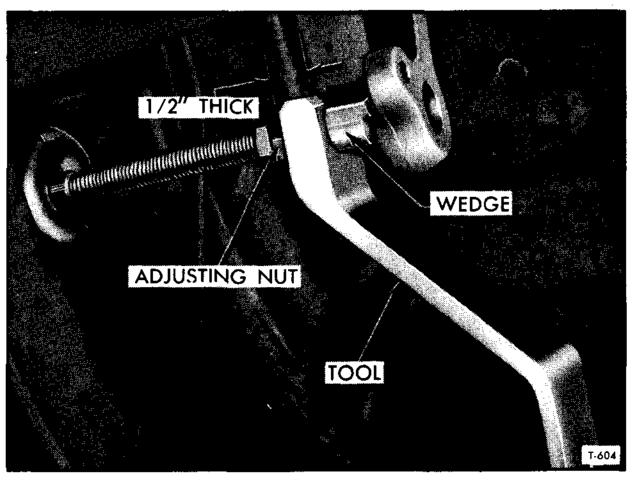


Figure 20—Using Large End of Tool

When the clutch facings wear (fig. 3), the release bearing "moves in" toward the flywheel. Since yoke position is fixed, the inward movement of the release bearing assembly reduces the original 1/8-inch clearance between the release yoke and bearing. At the same time, the gap between release bearing assembly and clutch brake will increase over the ½-inch. When the clutch wears the driver will note a loss in "free-pedal." Rotating the internal adjusting ring (fig. 3) to move the release bearing back to its original position will restore proper "free-pedal" travel. Continuing to operate the vehicle without "free-pedal" will load the release bearing and possibly cause premature failure. If the clutch is allowed to operate without "free-pedal" it will start to slip since it is being held in a partially released position.

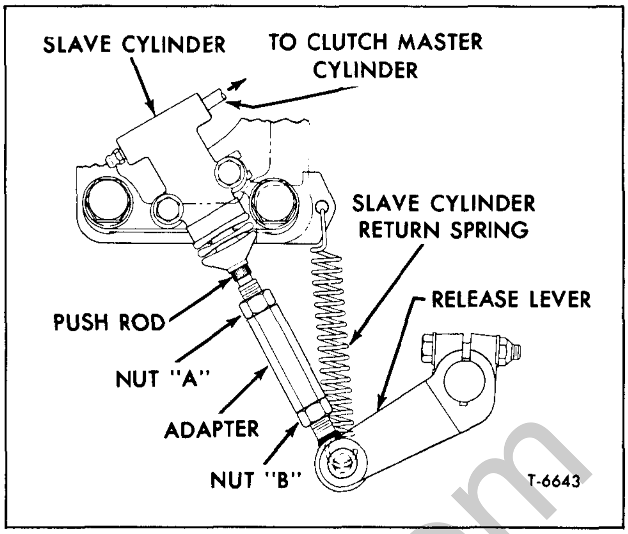


Figure 21—Clutch Controls with Spicer Clutch (HN, JN 90)

Internal Clutch Adjustment

NOTE: A tool for checking clearances at the release bearing can be improvised locally. See figure 4 which shows dimensions of tool.

1. Remove inspection hole cover from lower portion of the clutch housing.
2. The clearance between release bearing and clutch brake for a properly adjusted clutch is ½-inch as shown in figure 5. Using large end of tool (as shown in figure 6) check clearance between release bearing and clutch brake. If clearance is more or less than recommended, readjust clutch as follows:

CAUTION: TO PREVENT ACCIDENTAL STARTING PRIOR TO PERFORMING THE FOLLOWING STEP, BE SURE THE ENGINE CONTROL SWITCH IS IN THE "OFF" POSITION, TRANSMISSION GEARSHIFT LEVER IN NEUTRAL, AND THE VEHICLE'S WHEELS BLOCKED.

3. Have assistant pull compression release lever, then rotate flywheel until the adjusting ring lock (fig. 7) is exposed at inspection hole opening in bottom of clutch housing.
4. Referring to figure 7, remove cap screw and lock washer. Use screwdriver or similar wedge to pry adjusting ring lock free of the adjusting ring.

CAUTION: Use care when removing adjusting ring lock because it is spring-loaded in the adjusting ring notches.

5. Block the clutch pedal (in cab) down in a fully released position to remove spring load from adjusting ring inside the clutch.
6. Use a large screwdriver to turn adjusting ring.

NOTE: Turn adjusting ring CLOCKWISE to move release bearing OUT or away from flywheel. Turn the adjusting ring COUNTERCLOCKWISE to move rekease bearing assembly IN or toward the flywheel.

IMPORTANT: Rotation or movement of one lug position on the adjusting ring will move the release bearing approximately 0.020-inch; that is, 3 x 0.020 = 0.060 or 1/16-inch. 5 x 0.020 = 0.100 or 3/32-inch.

7. Remove block from clutch pedal to engage clutch and cycle the pedal a few times.
8. Recheck clearance between release bearing and clutch brake as described in Step 2 and readjust if necessary.
9. When satisfied that internal clutch adjustment is correct, install adjusting ring lock.

IMPORTANT: Align adjusting ring notch with slot in clutch ring and tap ring lock into position. Install lock washer and cap screw.

External Clutch Adjustment
(Refer to Fig. 21)

IMPORTANT: The external clutch adjustment should be performed, if necessary, only after internal clutch adjustment has been accomplished. Procedure for adjusting master cylinder is covered earlier in this section under "Master Cylinder Push Rod Check and Adjustment." The following steps must be performed when adjusting the slave cylinder:

1. Disconnect the slave cylinder return spring.
2. With the push rod and slave cylinder piston seated in the slave cylinder, the clearance between release bearing and yoke (free-travel) should be 1/8-inch as shown in figure 5. Using small end of

improvised tool (fig. 4) check clearance between yoke and release bearing as shown in figure 9.

3. If clearance is more or less than the recommended (1/8-inch) external linkage should be adjusted as follows:

a. Loosen nut "A" (left-hand threads) and nut "B" (right-hand threads).

b. Rotate release lever adapter, using a ¾-inch open-end wrench, until gap between yoke and release bearing is 1/8-inch as shown in figure 9.

c. Connect clutch lever return spring and cycle the pedal a few times.

NOTE: While assistant is cycling pedal check for yoke movement when pedal is depressed, to verify that "free-travel" in the cab is actually release bearing clearance.

d. Recheck clearance between yoke and release bearing as described in Step 2 and readjust if necessary.

e. When satisfied that free-travel is correct, tighten both nuts "A" and "B."

f. Install inspection hole cover in lower portion of clutch housing.

BLEEDING HYDRAULIC SYSTEM

Use only Hydraulic Brake Fluid recommended in LUBRICATION (SEC. 0) in this manual. When other than recommended fluid has been used, drain and flush the entire hydraulic system, using clean alcohol or a hydraulic brake system cleaning fluid. Refill system with RECOMMENDED fluid.

The need for bleeding air from system is generally indicated by a springy, spongy pedal action. The presence of air in system is a result of low fluid level in master cylinder, or if some part of system has been opened. Bleeder valve is provided at the slave cylinder (fig. 27.)

Clutch master cylinder is accessible under the hood on conventional cab models, through access door on TM80 and TV70 models, and under the dash on remaining steel tilt cab models.

Plain end of bleeder hose can be slipped over end of bleeder valve.

Clutch system may be bled either manually or with pressure bleeding equipment.

PRESSURE BLEEDING

1. Make sure fluid level in fluid supply pressure tank is up to pet cock above outlet and that tank is charged with 25 to 30 psi air pressure.

2. Clean dirt from around master cylinder cover or cap. On units having reservoir cover instead of cap, remove standard cover and install special cover (J-8554). Connect pressure tank hose to filler cap or special cover opening. Bleed air from hose before tightening connection. Open valves at both ends of hose.

CAUTION: On steel tilt cab models with master cylinder mounted inside of cab, use extreme care not to spill fluid on clutch or brake pedal pads. If fluid spills on pedal pads, it must be washed off so that pads will not be slippery.

3. Slip end of bleeder drain hose over bleed valve at slave cylinder (fig. 27) and place the other end in a glass jar containing enough hydraulic fluid to cover end of hose. Open bleeder valve with wrench and observe flow of fluid from hose. Close bleeder valve as soon as bubbles stop and fluid flows in a solid stream.

MANUAL BLEEDING

Manual bleeding is the same as pressure bleeding, except that the hydraulic fluid is forced through the line by pumping the clutch pedal. Fluid in master cylinder must be replenished after bleeding. Clutch pedal should be pumped up and down slowly and should be on downstroke as bleeder valve is closed.

CLUTCH PEDAL

CLUTCH PEDAL REPLACEMENT (CONVENTIONAL CAB MODELS)

These models have a suspended-type clutch pedal mounted in a bracket which is secured on the underside of the instrument panel. When the vehicle is equipped with air brakes the clutch pedal shaft is supported in nylon bushings installed in each end of a sleeve assembly (fig. 22). When hydraulic brakes are used, the pedal is supported at either end by nylon bushings at either end on the outside of the sleeve assembly.

<u>Removal</u>

1. Remove master cylinder push rod(s).
2. Unhook pedal return spring(s).
3. Loosen clamp bolt securing clutch pedal shaft lever on end of clutch pedal shaft and remove lever from shaft. Remove spring washer, bushings, and clutch pedal and shaft assembly from sleeve.
4. If necessary, remove bolt attaching sleeve assembly to mounting bracket. Remove sleeve assembly from bracket, at the same time removing brake pedal and bushings (when used).

<u>Installation</u>

Before installing clutch pedal, check each part, including bushings, for wear or other damage. Replace all damaged or worn items.

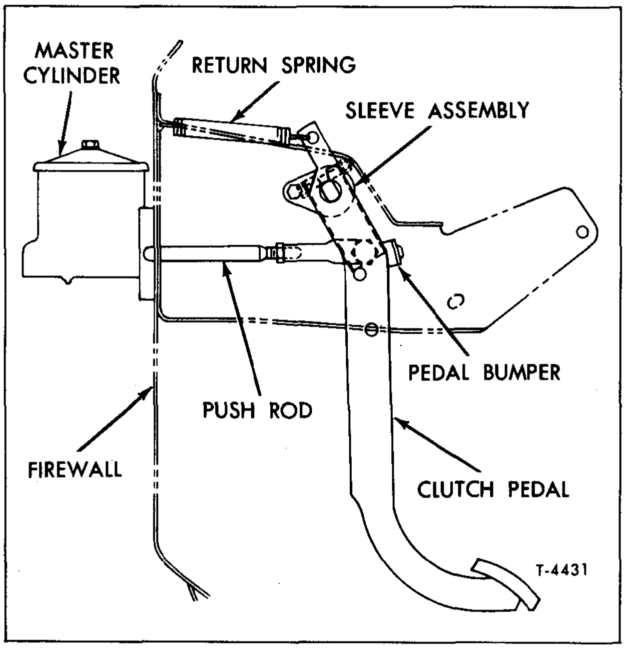


Figure 22—Clutch and Master Cylinder Installation (Conv. Cab Models)

1. Install bushings in brake pedal tube (when used). Position brake pedal at underside of instrument panel bracket. Insert sleeve assembly through bracket and pedal. Attach sleeve assembly to bracket with bolt and nut. Tighten nut to 20-25 foot-pounds torque.

2. Install bushings in sleeve assembly. Insert clutch pedal shaft through sleeve and install spring washer and pedal shaft lever on end of clutch shaft. Install pedal shaft lever clamp bolt and nut. Tighten nut to 25-30 foot-pounds torque.

3. Connect pedal return springs.

4. Connect push rod(s) to master cylinder using shoulder bolts, washers, and nuts. Tighten nut(s) to 20-25 foot-pounds and retain in position with cotter pin(s).

5. Adjust clutch pedal push rod, as described previously under "Master Cylinder Push Rod Check and Adjustment." For adjustment of brake pedal push rod refer to "HYDRAULIC BRAKES" (SEC. 5A) in this manual.

CLUTCH PEDAL REPLACEMENT (TILT CAB MODELS - TM80 & TV70)

Removal

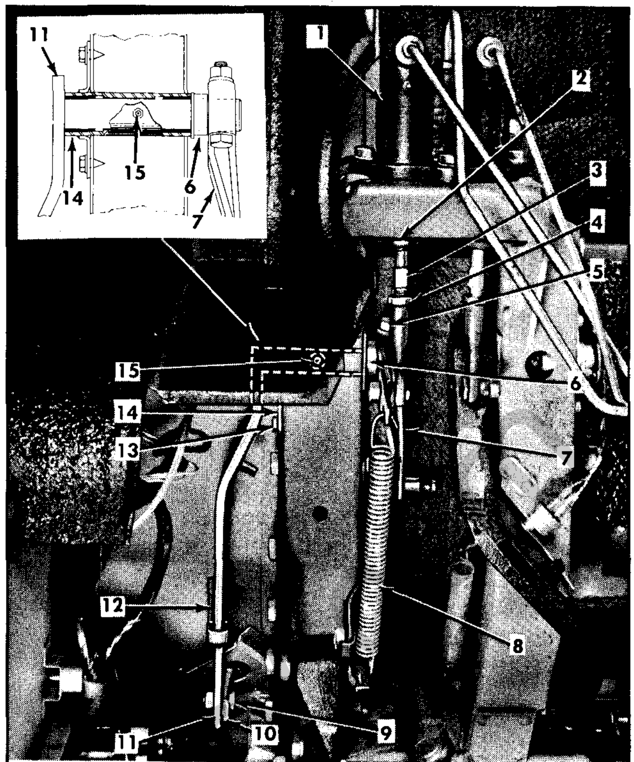
NOTE: Key numbers in text refer to figure 23.

1. Tilt cab forward.

IMPORTANT: Make sure cab safety catch at right front pivot mounting is securely engaged.

2. Disconnect pedal return spring (8).

3. Separate pedal upper section (10) from lower section (11) after removing attaching bolt (9).



1 Master Cylinder	9 Pedal Attaching Bolt
2 Push Rod Boot	10 Pedal (Upper Section)
3 Master Cylinder Push Rod	11 Pedal (Lower Section)
4 Push Rod Lock Nut	12 Pedal Stop (Bumper)
5 Lever-to-Shaft Clamp Bolt	13 Sleeve Attaching Screws
6 Special Spacer	14 Sleeve and Bushing Assy.
7 Pedal Shaft Lever	15 Lubrication Fitting
8 Pedal Return Spring	TPM-9985

Figure 23—Clutch Pedal and Linkage (Typical—TM 80 and TV 70)

4. Loosen bolt (5) which clamps pedal shaft lever (7) to pedal shaft. Slide pedal and shaft assembly (11) from cab sill and from spacer (6), and pedal shaft lever (7).

5. Through small access hole at base of cab sill, remove the pedal shaft lubrication fitting (15).

6. Remove two hex-head screws (13) which attach the flange of pedal shaft sleeve and bushing assembly (14) to the cab sill.

7. Using a pointed tool under flange of sleeve, pry shaft sleeve and bushing assembly (14) from cab sill.

Installation

NOTE: Key numbers in text refer to figure 23.

1. Temporarily install pedal shaft back into sleeve and bushing assembly (14) and check for excessive wear. If necessary, press worn bushings from sleeve and press new bushings in their place. After installing new bushings it may be necessary

to ream or burnish the bushings. Original bushings were reamed to 0.8715" to 0.8725".

2. Making sure that the lubrication fitting hole is at the bottom, insert sleeve and bushing assembly (14) into cab sill and secure with two screws (13).

3. Install lubrication fitting (15) into tapped hole at bottom of sleeve.

4. Slide pedal and shaft assembly (11) through sleeve assembly (14), through special spacer (6), and into the partly serrated hole of the pedal shaft lever (7). Make sure shaft lever is positioned as shown in figure 13.

5. Remove all shaft end play, then clamp pedal shaft lever (7) to end of shaft by tightening lever clamp bolt (5) and nut.

6. Attach pedal upper section (10) to pedal lower section (11) with bolt (9), nut, and washer.

IMPORTANT: Make sure that bolt is inserted in direction shown.

7. Referring to figure 23, install clutch pedal return spring (8).

IMPORTANT: Exercise caution when installing spring.

8. Make sure that pedal stop (12) is in good condition and is located on pedal shaft as shown.

9. Adjust clutch controls as described previously under "Clutch Control Adjustments."

CLUTCH PEDAL (STEEL TILT CAB MODELS), EXCEPT TM80 & TV 70)

The clutch pedal is part of the master cylinder assembly. Since the pedal and master cylinder must be removed as a unit, replacement of the pedal is described under "Clutch Master Cylinder."

CLUTCH MASTER CLYINDER

DESCRIPTION

Three different types of master cylinders are used on vehicles covered by this manual: Double-barrel horizontal type, single-barrel horizontal type, and single-barrel vertical type.

Double-Barrel Horizontal Type
(Refer to Fig. 24)

NOTE: Figure 24 shows section through clutch cylinder only.

Double-barrel master cylinder is used on TM80 and TV70 models. The unit consists of two cylinders with an integral reservoir. The brake cylinder bore (left-side) is larger than the clutch master cylinder (right-side). Due to the different sized bores, the pistons and cups used in the two cylinders are of different sizes. Spring and retainer assemblies are of different lengths; the longer spring is used in the clutch cylinder, the shorter spring in the brake cylinder. The clutch cylinder does not use a residual line pressure check valve, as will be found in the brake cylinder. The unit shown in figure 25 has mounting flange at rear of housing, and an adjustable push rod for adjusting pedal linkage.

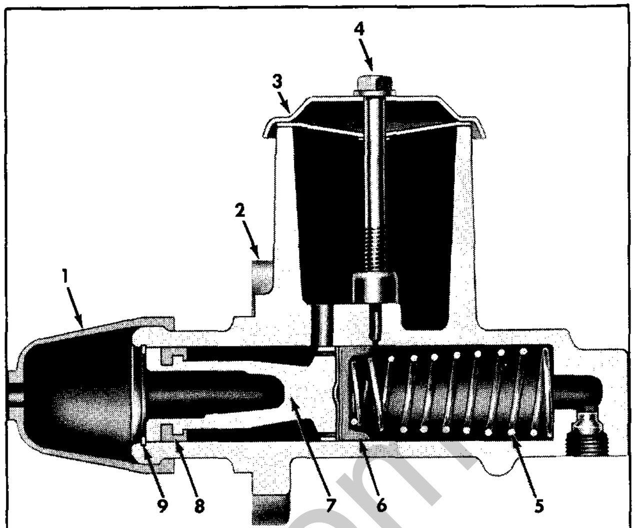


Figure 24—Clutch Master Cylinder (Conv. Cab, TM 80, and TV 70)

Single-Barrel Horizontal Type
(Refer to Fig. 24)

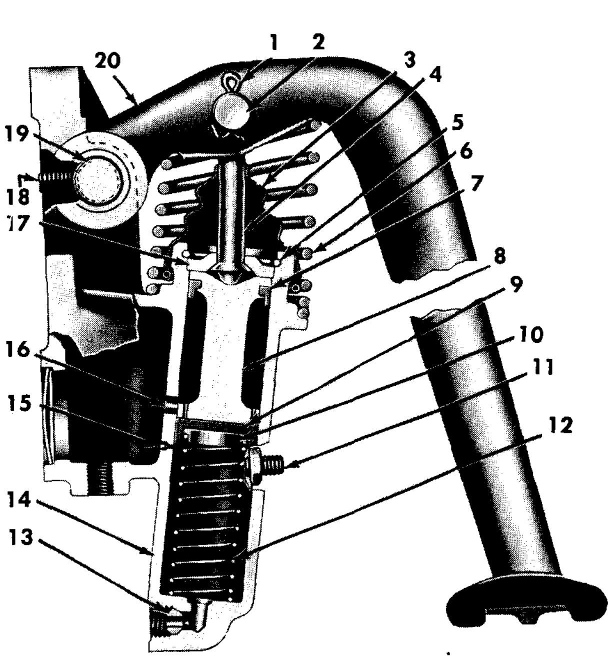
Clutch master cylinder used on conventional cab models is a single-barrel version of the unit described previously. The cylinder bore is 1-1/8-inch in diameter.

Single-Barrel Vertical Type
(Refer to Fig. 25)

Clutch master cylinder used on steel tilt cab models excluding TM80 and TV70 is a vertical cylinder with integral reservoir, mounting flanges, and clutch pedal support (fig. 25). The cylinder assembly is mounted on dash inside of cab. Pedal is mounted on a shaft which is secured in support by a socket-head setscrew. Master cylinder piston push rod is attached to pedal with a clevis pin and cotter pin. Pedal return spring, installed between cylinder housing and underside of pedal lever, insures full return of master cylinder piston and pedal when pedal is releaed. Since the pedal-to-cylinder relationship is fixed, no push rod adjustment is required.

GENERAL MAINTENANCE (ALL TYPES)

Filler cap or cover on all clutch master cylinders is designed to vent the fluid reservoir with-



1 Push Rod Pivot Cotter Pin
2 Push Rod Pivot Pin
3 Push Rod Boot
4 Push Rod
5 Piston Retainer Plate Snap Ring
6 Pedal Return Spring
7 Secondary Piston Seal
8 Piston
9 Primary Piston Seal
10 Seal Expander
11 Pedal Stop Set Screw and Locknut
12 Piston Return Spring
13 Fluid Outlet Port
14 Main Cylinder Body Casting
15 Bypass Port
16 Intake Port
17 Piston Retainer Plate
18 Pedal Pivot Pin Set Screw
19 Pedal Pivot Pin
20 Pedal Lever

TPM-7498-1

Figure 25—Clutch Master Cylinder (Steel Tilt Cab Models, Except TM 80 and TV 70)

out permitting loss of fluid. A small baffle is inserted into filler cap as shown in figure 28 on all steel tilt cab models except TM80 and TV70. Bypass port between cylinder bore and reservoir and vent hole in filler cap must be kept open to assure proper clutch control. An obstructed bypass port will prevent return of fluid to reservoir, preventing full engagement of clutch. Bypass ports may be obstructed by one of the following:

1. Clogged with dirt -- remove master cylinder and disassemble and clean all parts. Refer to applicable section view of master cylinder when assembling.
2. Swollen primary cup due to the use of wrong fluid -- service the master cylinder, drain and flush entire clutch control system, and refill with proper fluid.
3. Pedal binding on shaft, preventing full return of piston -- free up and lubricate pedal.

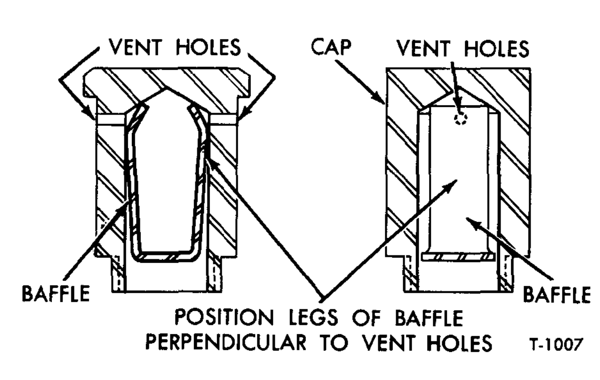


Figure 26—Master Cylinder Filler Cap Baffle (Steel Tilt Cab Models, Except TM 80 and TV 70)

4. Improper push rod adjustment -- adjust push rod (if used).

MASTER CYLINDER REPLACEMENT (TM80 AND TV70 MODELS)

Removal

1. Tilt cab forward and place a suitable container under master cylinder to catch fluid when hydraulic lines are disconnected.

NOTE: DO NOT RE-USE THIS FLUID.

2. Disconnect hydraulic lines from outlets of brake and clutch cylinders.
3. Pull push rod boots off master cylinder. Boots will remain on push rods when master cylinder is removed.
4. Remove three bolts attaching master cylinder to support bracket and remove master cylinder assembly.

Installation

1. Position master cylinder assembly at support bracket and guide push rods into pistons. Attach cylinder with three bolts. Tighten bolts firmly.
2. Connect hydraulic lines to brake and clutch cylinder outlets.
3. Place push rod boots over ends of master cylinder brackets.
4. Adjust clutch push rod as directed under "Master Cylinder Push Rod Check and Adjustment" and adjust brake push rod as described in "HYDRAULIC BRAKES" (SEC. 5A) of this manual.
5. Fill master cylinder reservoir and bleed system as directed previously for clutch system.

For bleeding brake system refer to "HYDRAULIC BRAKES" (SEC. 5A) of this manual.

MASTER CYLINDER REPLACEMENT (CONVENTIONAL CAB MODELS)

Removal

1. Place a suitable container under master cylinder to catch fluid when hydraulic line is disconnected. DO NOT RE-USE THIS FLUID.
2. Disconnect hydraulic line from outlet of clutch cylinder.
3. Pull push rod boots off master cylinder tube which extend through dash. Boot will remain on push rod when master cylinder is removed.
4. Remove three bolts and lock washers attaching master cylinder to dash (nuts are welded to inner side of dash) and remove master cylinder assembly.

Installation

1. Place gasket over cylinder tube. Position master cylinder assembly at dash, while an assistant inside cab guides push rod into piston. Attach cylinder to dash with three bolts and lock washers. Tighten bolts firmly.
2. Connect hydraulic lines to clutch cylinder outlet.
3. Inside cab, place push rod boot over end of cylinder tube.
4. Adjust push rod as previously directed under "Master Cylinder Push Rod Check and Adjustment."

MASTER CYLINDER REPLACEMENT (STEEL TILT CAB MODELS, EXCEPT TM80 AND TV70)

Removal

1. Place a suitable container inside cab under the master cylinder to catch fluid when hydraulic line is disconnected.

NOTE: DO NOT RE-USE THIS FLUID.

2. Disconnect hydraulic line from master cylinder and place a suitable cap over line to prevent entry of dirt into hydraulic system.
3. Remove attaching parts retaining master cylinder to fire wall and remove unit from vehicle.

Installation

1. Install new or rebuilt master cylinder on fire wall. Tighten attaching parts firmly.
2. Remove protective cap from hydraulic line and connect line to master cylinder.
3. Adjust stop screw as described previously under "Clutch Pedal Stop Screw Adjustment."
4. Fill master cylinder and bleed system as described previously under "Bleeding Hydraulic System."

MASTER CYLINDER REPAIR

The following procedures cover disassembly, cleaning, inspection and repair, and assembly of components used in the clutch cylinder bore. Refer to applicable master cylinder illustration.

Disassembly

1. Clean all dirt from outside of unit, using a non-petroleum solvent.
2. Remove snap ring from groove in cylinder bore.
3. Remove piston assembly, primary cup, return spring and retainer assembly from clutch cylinder bore.
4. Remove cover from cylinder housing.

Cleaning

Immerse all parts in denatured alcohol and wash thoroughly. Wipe small parts dry and blow out inside of reservoir and cylinder bore. Make sure intake and bypass ports in cylinder housing and bleeder holes in piston are clean.

CAUTION: DO NOT use kerosene or gasoline for cleaning master cylinder components.

Inspection and Repair

Master cylinder repair kits are available which contain all the parts ordinarily required when servicing master cylinders. Refer to applicable Parts Book for part number of repair kit. In addition to replacement of parts contained in repair kit, master cylinder should be inspected and repaired, if necessary, as follows:

1. Examine cylinder bore. If scored or rusted, recondition by honing. Be sure to use proper size hone. Clutch cylinder bore is 1-1/8-inch. Do not hone more than necessary to remove scores and smooth up cylinder. Remove burrs caused by honing from around by-pass and intake ports.

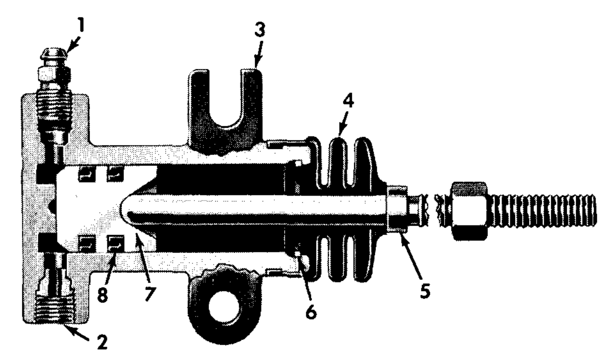


Figure 27—Clutch Slave Cylinder

2. Check piston fit in cylinder bore. Clearance between piston and cylinder wall should be within 0.001" to 0.006" when checked with feeler gauge.

Assembly

1. Before assembling, coat inside of cylinder bore and dip all internal parts in hydraulic brake fluid.

2. Install components in clutch cylinder bore as follows:

a. Install return spring in cylinder bore, with large diameter first.

b. Install primary cup in cylinder bore with lip of cup toward outlet end. Make sure end of spring seats inside the cup.

c. Insert piston and secondary cup into cylinder bore, with open end of piston toward open end of cylinder.

d. Press piston into cylinder bore, compressing spring, and install snap ring in groove in bore.

NOTE: Install piston stop plate in cylinder used on "R" Models. Make sure snap ring is fully seated in groove.

3. Check clearance between edge of primary cup and the bypass port in each cylinder as follows:

a. From inside the reservoir, insert a straight wire (tag wire or any wire of approximately 0.010" diameter) through the bypass port.

b. While moving the wire up and down in the bypass port, push the piston in very gently until a slight drag is felt on the wire. Check clearance between end of piston and snap ring. Clearance should be 0.035 inch minimum. If less than 0.035-inch, the wrong size cup or a swollen cup has been installed, or the parts were improperly assembled. Disassemble unit and reassemble, using the correct parts.

4. Install cover on cylinder reservoir.

CLUTCH CONTROL SLAVE CYLINDER

Clutch control slave cylinder assembly is mounted at side of clutch housing or transmission. When cylinder is pressurized it activates the mechanical clutch release fork or lever to disengage clutch.

Components of cylinder consists of an aluminum piston with two captive block-type seals (fig. 27). The return of the piston on clutch apply is provided for by the external return spring.

REMOVAL

1. Remove return spring from clutch release fork or lever.

2. Disconnect fluid line at slave cylinder.

3. Remove bolts retaining slave cylinder at mounting, then remove cylinder assembly.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 27.

1. Remove cylinder push rod (5) and push rod boot (4) from cylinder.

2. Remove piston retaining ring (6) from slave cylinder, using a small screwdriver.

CAUTION: DO NOT mar bore of cylinder body.

3. Remove piston assembly (7) with seals (8) from cylinder body (3).

NOTE: Piston can be jarred from body or small amount of air pressure at line fitting will force piston from bore. Do not allow piston to become damaged after it is removed.

4. If seals (8) are in good condition they need not be removed.

INSPECTION

NOTE: Key numbers in text refer to figure 27.

1. Inspect slave cylinder bore, making sure that it is smooth. A scored or damaged cylinder body (3) must be replaced.

NOTE: Burrs at the bore side of inlet port can be removed by honing or by use of crocus cloth.

2. Check piston seals (8) if removed. Swelling of seals could be due to use of improper brake fluid.

3. Check fit of the piston in the cylinder bore, using a feeler gauge. This clearance should be from 0.002" to 0.004".

ASSEMBLY

NOTE: Key numbers in text refer to figure 27.

1. Install seals (8) into grooves of piston (7) with lips of seals positioned to fluid end of piston (fig. 29).

2. Dip piston and seals in clean brake fluid, then carefully install piston assembly in bore of cylinder. Refer to figure 19 for proper position of piston in cylinder.

3. Install retaining ring (6) in groove at open end of cylinder.

4. Install boot (4) over push rod (5) and install rod and boot to slave cylinder.

INSTALLATION

1. Bolt slave cylinder assembly to mounting.

2. Adjust slave cylinder push rod clearance as outlined in this section under "Clutch Control Adjustments."

3. Attach hydraulic line to slave cylinder and bleed air from system at slave cylinder bleed fitting. See "Bleeding System" previously in this section.

CLUTCHES

CLUTCH APPLICATION CHART

Clutch Type	Engine Application
Lipe-Rollway (13-Inch Dual Disc)	401M
Long (13-Inch Dual Disc)	401M
Lipe-Rollway (14-Inch Dual Disc)	478M, 6V-53, 6-71 8V-71, NH-230, NHC-250, NHCT-270
Long (14-Inch Dual Disc)	478M, 6V-53
Spicer (14-Inch Dual Disc)	NH-230, NHC-250, NHCT-270
Spicer (15½-Inch Dual Disc)	8V-71, NH-230, NHC-250 NHCT-270, NTC-335

CLUTCH REPLACEMENT (LIPE-ROLLWAY AND LONG CLUTCHES)

> IMPORTANT: Whenever clutch components require replacement, use only genuine General Motors parts to assure maximum clutch performance and life.

CLUTCH REMOVAL

(Refer to Figures 1 and 2)

1. Remove transmission assembly from vehicle as directed in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B) previously.

NOTE: On vehicles equipped with a clutch release fork, remove release bearing and support assembly from release fork.

2. Remove clutch release fork (when used) from ball stud by prying it away from the ball with a screwdriver until it snaps loose from the ball.

3. Install aligning tool or an old transmission main drive gear into the hubs of the clutch driven discs to support the clutch components during removal.

IMPORTANT: To facilitate removal of the Long clutch cover assembly, install three hardwood blocks between the release levers and cover as shown in figure 3.

On Lipe-Rollway clutches, install three flat washers and hold-down bolts as shown in figure 4.

4. Mark the clutch cover and intermediate drive plate in relation to the engine flywheel to assure original positioning of the clutch components during "Clutch Installation."

5. Loosen the cover bolts alternately one turn at a time to avoid creating undue stresses in the clutch cover.

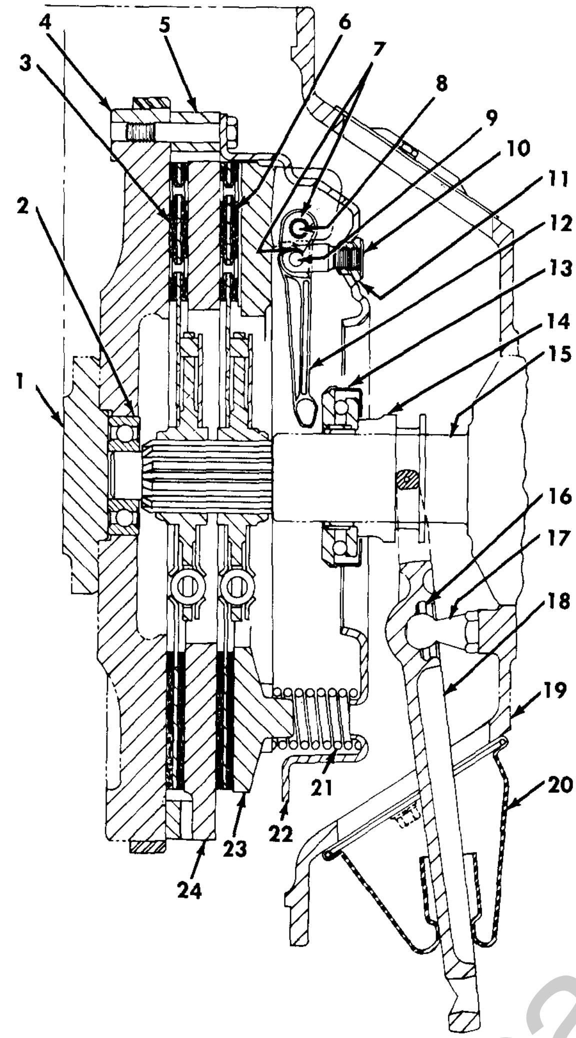
6. With the aid of aligning tool or old transmission main drive gear remove complete clutch assembly from flywheel.

INSPECTION AND REPAIR

The following procedures apply to all clutch components with exceptions as indicated.

CLUTCH RELEASE MECHANISM (FORK-TYPE)

1. Check release fork and ball stud for wear, distortion, cracks, or other damage.
2. Check release bearing for roughness or noise by rotating bearing race while applying light pressure.
3. Replace all components that would affect proper operation of the clutch release mechanism.
4. Prior to installation of clutch release bearing and support assembly (fig. 5), fill the inside groove and coat the outside groove with a small quantity of high temperature grease.



1 Engine Crankshaft
2 Pilot Bearing
3 Driven Disc Assembly (Front)
4 Engine Flywheel
5 Drive Ring
6 Driven Disc Assembly (Rear)
7 Needle Bearing Rollers
8 Release Lever Pin
9 Yoke Pin
10 Lock Plate
11 Adjusting Nut
12 Release Lever
13 Release Bearing
14 Release Bearing Support Assy.
15 Transmission Bearing Cap
16 Release Fork Retainer Spring
17 Release Fork Ball Stud
18 Release Fork
19 Clutch Housing
20 Release Fork Boot
21 Pressure Spring
22 Clutch Cover
23 Pressure Plate
24 Intermediate Plate

T-6681

Figure 1—13-Inch Dual Disc Clutch (Typical)

IMPORTANT: An excessive amount of lubricant applied to release bearing could spin off the bearing and damage other clutch components.

CLUTCH RELEASE MECHANISM
(YOKE-TYPE)

Check bearing for roughness or noise by rotating bearing race while applying light pressure. Replace the bearing if it is rough, noisy, or when damaged.

Removal (Refer to Fig. 6)

1. Remove release lever from clutch release yoke cross shaft.
2. Disconnect flexible lubrication tube from top of release bearing support. Remove two retaining springs from top of bearing support. Slide release bearing and support assembly off end of transmission bearing cap.
3. Remove two cap screws which attach release yoke to cross shaft, then drive the yoke to one side to expose two drive keys. Remove keys, then drive shaft out of yoke and remove from the housing.

Installation (Refer to Fig. 6)

1. Hold clutch release yoke in position in clutch housing, then insert release cross shaft through one side of clutch housing, through release yoke and out through opposite side of housing.
2. Install two keys in cross shaft, then move yoke into place with keys engaging keyway in yoke. Do not tighten bolts until after release bearing and support assembly is assembled to bearing cap.
3. Examine contact buttons on ears of bearing support for worn condition. Buttons can be pressed out or into support if necessary.
4. Slide release bearing and support assembly

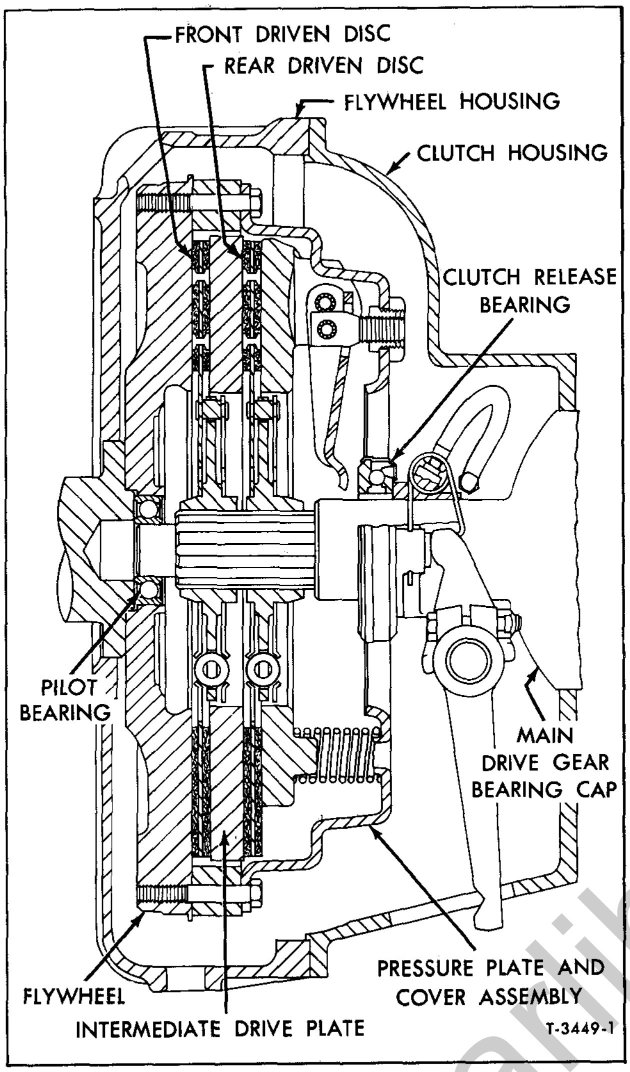


Figure 2—14-Inch Dual Disc Clutch

on bearing cap to contact fingers of release yoke.

5. Install retaining springs, then connect lubrication tube to top of support.
6. Check cross shaft and yoke to make sure they are properly centered, then tighten yoke clamp bolts.
7. Install release lever on yoke cross shaft with drive key in slot of shaft. Lever should be positioned on shaft so that it is directly in line with center of slave cylinder push rod. Tighten lever clamp bolt firmly.
8. Fill grease cup with lubricant as specified in LUBRICATION (SEC. 0) of this manual, and turn down cup to provide initial lubrication to support. Also, lubricate clutch cross shaft bushings, using fitting at each side of clutch housing.

PILOT BEARING

Corrosion or roughness on either the race or

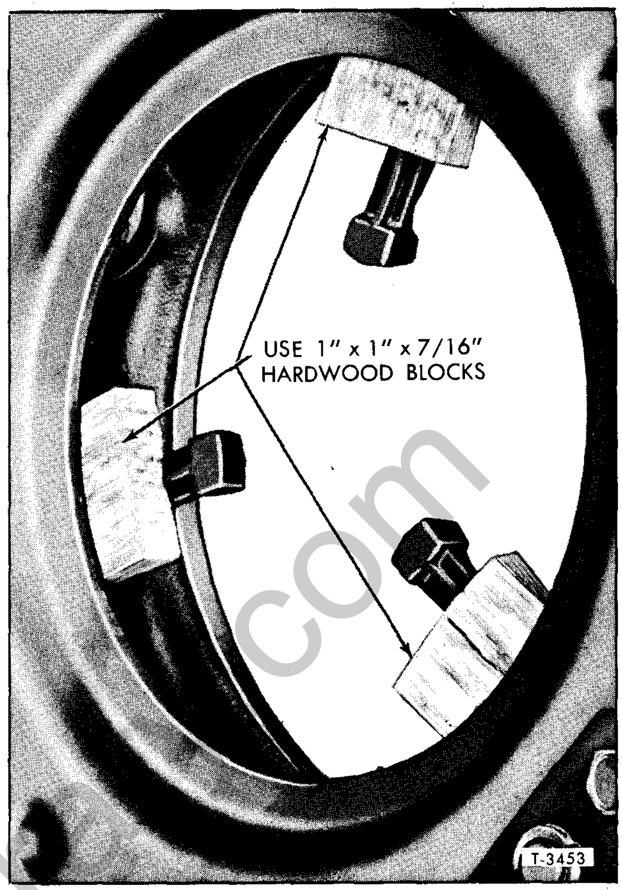


Figure 3—Use of Blocks Between Release Lever and Cover (Long Clutch)

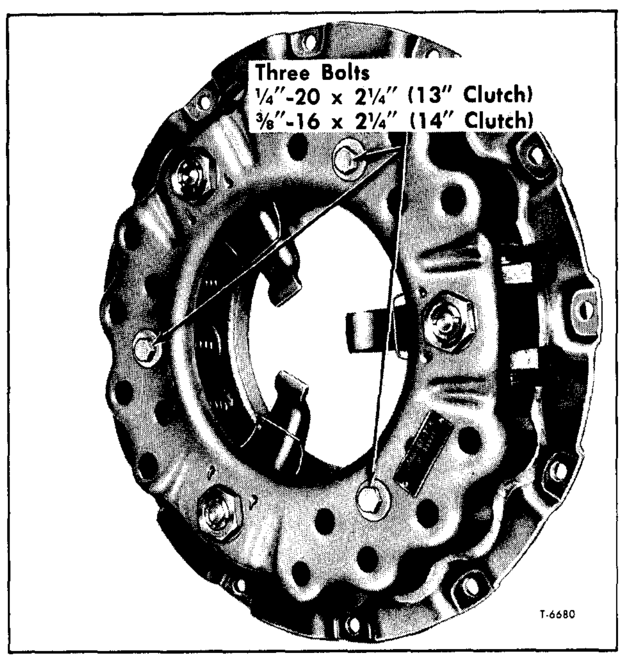


Figure 4—Clutch Cover Hold-Down Bolts (Lipe-Rollway Clutch)

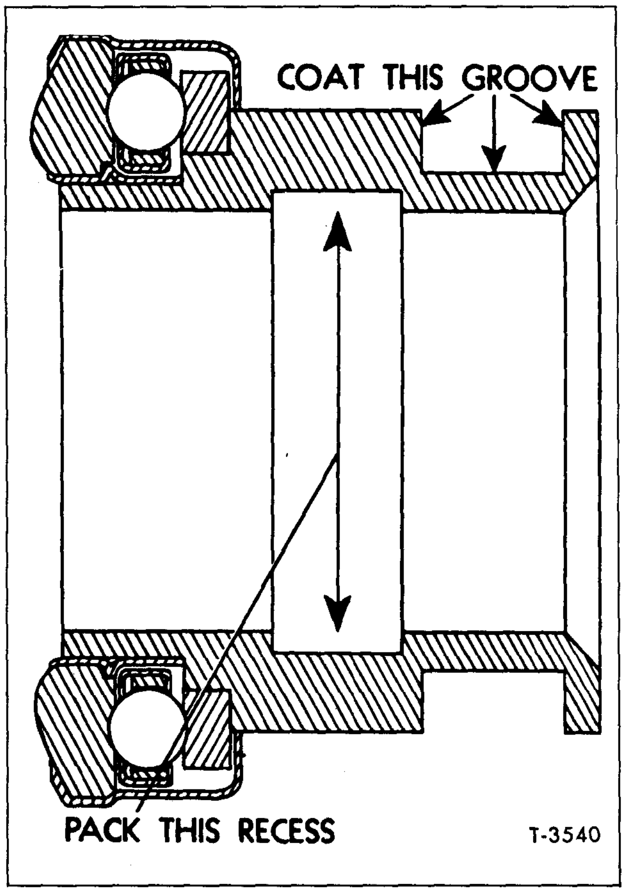


Figure 5—Release Bearing and Support Assembly (Typical)

balls can be detected by rotating bearing inner race with finger.

Removal

Remove clutch pilot bearing assembly from engine, using pilot bearing remover (J-5901-2) with slide hammer (J-2619). With fingers on puller closed, insert fingers through bearing inner race as far as they will go, then tighten thumb screw to spread fingers. Slide weight sharply against stop on puller shaft to remove bearing.

Installation

1. Pack clutch pilot bearing with small quantity of high temperature lubricant specified in LUBRICATION (SEC. 0) of this manual.
2. With shielded side of bearing toward the rear, drive pilot bearing into position using a suitable driver. Bearing should be seated firmly.

FLYWHEEL, INTERMEDIATE DRIVE PLATE, AND PRESSURE PLATE

Inspect surface which is contacted by the clutch facing. This surface must be smooth and should not be grooved or show deep heat checks. Replace if the above conditions are evident.

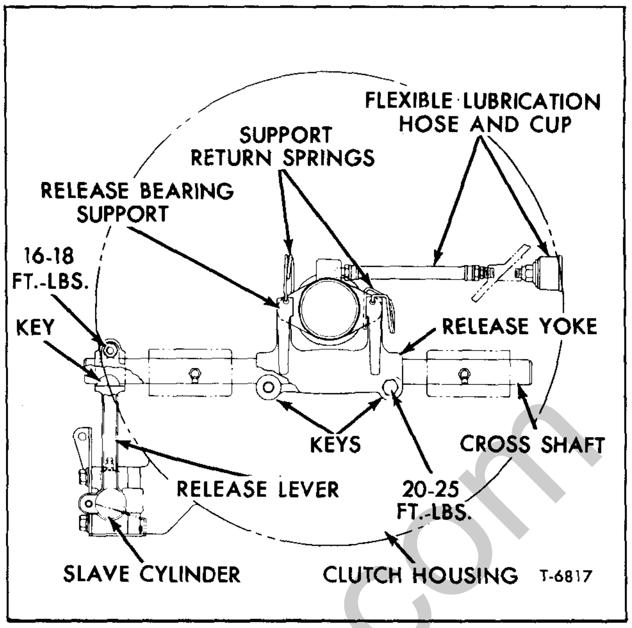


Figure 6—Clutch Release Mechanism (Yoke Type)

DRIVEN DISCS

Inspect driven disc assembly for worn, loose, and grease or oil-soaked facings. Check for broken springs, loose rivets, or cracks in the driven disc hub. Examine splines in hub for wear and make sure they slide freely on splines of the main drive gear. If any wear or damage is evident, replace with a new driven disc assembly.

PRESSURE PLATE AND COVER ASSEMBLY

Detailed inspection and repair procedures for the pressure plate and cover assembly are not covered in this manual.

CLUTCH INSTALLATION

(Refer to Figures 1 and 2)

1. Be sure the wood blocks (fig. 3) or hold-down bolts and washers (fig. 4) are installed in the clutch cover assembly.
2. Place front driven disc against flywheel. Place intermediate drive plate against the front driven disc. Then place rear driven disc against intermediate drive plate.

NOTE: Be sure the larger exposed portion of disc damper springs face the pressure plate.

3. Move clutch cover assembly into position against dual disc assembly. Insert alignment tool or old transmission main drive gear into pilot bearing.
4. If alignment marks were made on clutch cover and engine flywheel prior to removal, align these marks.

CLUTCH TROUBLESHOOTING (LIPE AND LONG)

SYMPTOMS AND PROBABLE CAUSE	PROBABLE REMEDY
SLIPPING	
1. Improper adjustment.	1. Adjust slave cylinder travel clearance or if control is of link type, make adjustment at release fork or lever adjustment rod.
2. Oil soaked clutch disc.	2. Install new disc.
3. Worn splines on transmission drive gear.	3. Replace drive gear.
4. Lining loose on clutch disc.	4. Install new disc.
5. Warped pressure plate or engine flywheel.	5. Replace pressure plate or flywheel.
GRABBING	
1. Oil on disc lining.	1. Install new disc.
2. Worn splines on transmission drive gear.	2. Replace drive gear.
3. Loose engine mountings.	3. Tighten or replace engine mountings.
4. Warped pressure plate or engine flywheel.	4. Replace pressure plate or flywheel.
RATTLING	
1. Weak retracting springs.	1. Replace springs.
2. Release fork loose on ball pivot stud.	2. Check stud and retaining spring and if necessary, replace.
NOISY	
1. Worn clutch release bearing.	1. Replace release bearing.

HYDRAULIC CONTROLS

PEDAL SPONGY	
1 Air in clutch hydraulic line.	1. Bleed clutch slave cylinder.
EXCESSIVE PEDAL TRAVEL	
1. Leaking slave cylinder line.	1. Tighten or replace line.
2. Fluid low in hydraulic master cylinder.	2. Fill cylinder to 1/2" below top of reservoir.
3. Clutch master cylinder push rod lever loose or not properly adjusted.	3. Adjust length of clutch push rod under dash.
CLUTCH PEDAL RELEASES CLUTCH BUT PEDAL GRADUALLY TRAVELS DOWNWARD	
1. Clutch master cylinder leaks past primary cup.	1. Overhaul master cylinder.
2. External leaks.	2. Tighten all line fittings and check for leaks in line.

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5. Install cover-to-flywheel bolts and washers. Tighten bolts alternately one turn at a time to compress clutch pressure springs evenly and prevent possible distortion of cover.

NOTE: Tighten clutch cover-to-flywheel bolts to 35-45 foot-pounds torque. Remove aligning tool.

IMPORTANT: After installing clutch cover assembly be sure to remove wood blocks or hold-down bolts and washers (refer to figs. 3 and 4).

6. Clutch release mechanism (fork-type):

a. Be sure clutch release bearing and support assembly (fig. 5) is lubricated as described previously under "Inspection and Repair."

b. Install release fork ball stud to the clutch housing. Tighten ball stud to 30-40 ft.-lbs. torque.

c. Apply a small amount of high temperature grease to ball stud recess in release fork, then install ball stud retainer spring in fork. Force ball stud into fork recess until engaged by spring.

d. Position release bearing in yoke portion of release fork.

7. Clutch release mechanism (yoke-type):

a. Be sure clutch release bearing and support assembly is lubricated as described previously under "Clutch Release Mechanism."

8. Install transmission assembly as described in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B) in this manual.

CLUTCH REPLACEMENT (SPICER CLUTCHES)

IMPORTANT: Whenever clutch components require replacement, use only genuine General Motors parts to assure maximum clutch performance and life.

CLUTCH REMOVAL

(Refer to Figures 7 and 8)

1. Remove transmission assembly from vehicle as directed in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B) of this manual.

2. Install aligning tool or an old transmission main drive gear into the hubs of the driven discs to support the clutch assembly during removal.

3. Install two ¾-inch blocks of wood between the front of clutch release bearing and clutch spring plate hub (see fig. 9). The wood blocks will relieve the heavy internal spring load, preventing the clutch from cocking during removal.

NOTE: Mark flywheel ring in relation to engine flywheel to assure original positioning when reassembled later if either part is to be reused.

4. Perform the following on the Spicer 15½-inch clutch:

a. Remove two upper clutch-to-flywheel mounting bolts and insert, in their place, two 7/16"-14NC (5" long) guide studs.

b. When all clutch-to-flywheel mounting bolts have been removed, slide clutch assembly back on studs using caution to prevent dropping of front disc or intermediate drive plate.

c. It is suggested that a sling be rigged with a small chain hoist to assist lowering the clutch from assembly studs to floor. The Spicer 15½-inch clutch assembly weighs approximately 150 pounds.

5. Loosen the clutch-to-flywheel cap screws alternately one turn at a time to avoid creating undue stresses in flywheel ring.

6. Remove clutch assembly from vehicle and lower to floor.

INSPECTION AND REPAIR

Inspection and repair procedures for Spicer clutches is the same as covered earlier in this section for Lipe-Rollway and Long clutches, except checking clearance between intermediate drive plate and flywheel on the Spicer 14-inch dual disc clutch, as explained in the following:

CHECKING CLEARANCE BETWEEN INTERMEDIATE DRIVE PLATE AND FLYWHEEL (SPICER 14-INCH CLUTCH)
(Refer to Fig. 7)

1. Be sure the flats on the six drive pins are parallel with center line of flywheel. Also drive pins should be equally spaced around the flywheel.

2. Check clearance of slots in intermediate drive plate by positioning plate on the drive pins. Clearance should be 0.006- to 0.014-inch and measured on same side of drive pins. If alignment and clearance are satisfactory, remove intermediate plate and lock drive pins in place with socket head setscrews.

CLUTCH INSTALLATION

(Refer to Figures 7 and 8)

1. If wood blocks have not been installed between the release bearing and spring plate hub, perform the following:

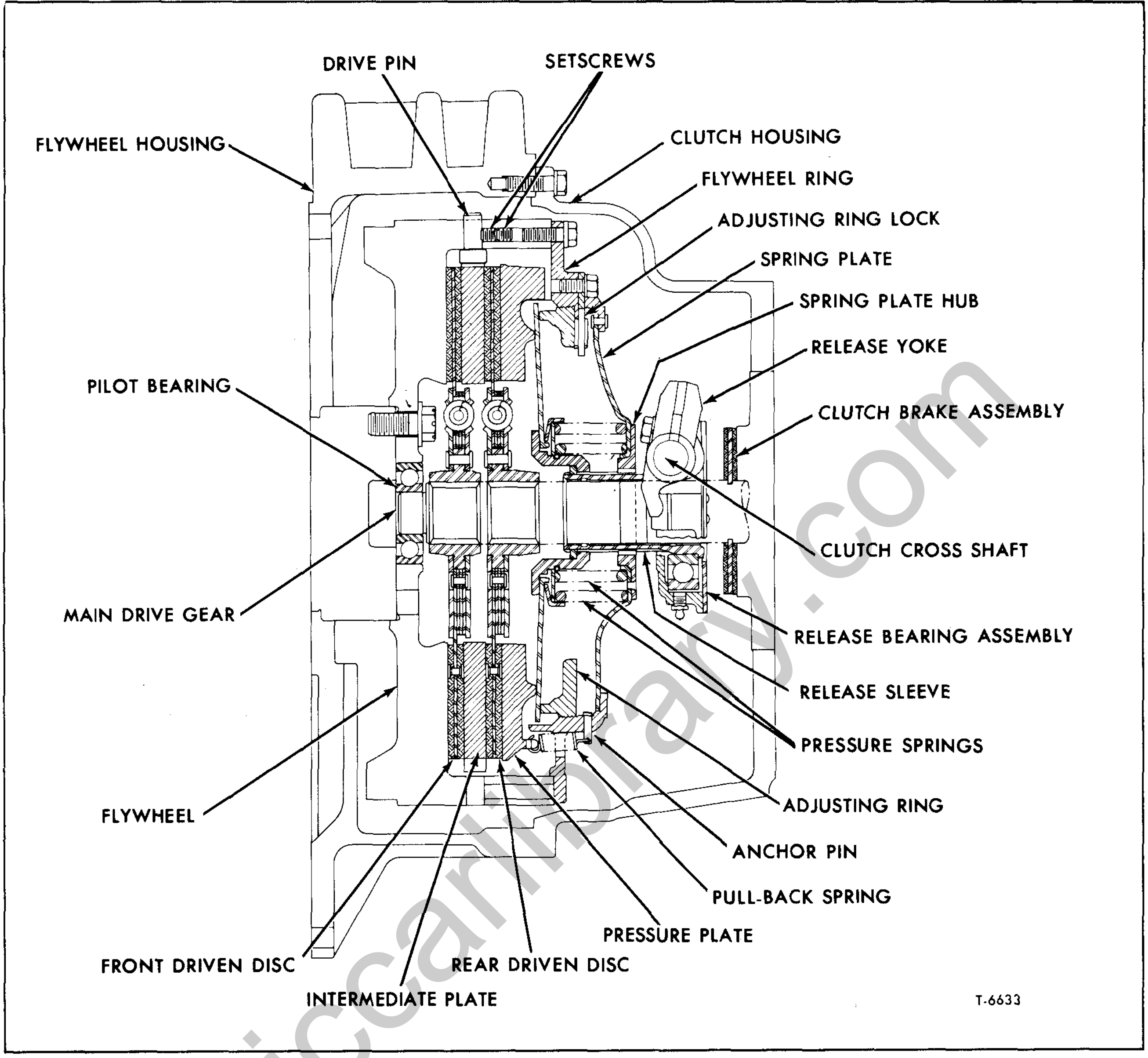


Figure 7—Spicer 14-Inch Dual Disc Clutch

a. Turn clutch assembly over on bed of arbor press and rest end of release sleeve on piece of 2½-inch O.D. tubing.

b. Use the 2 x 4 bridge as shown in figure 10 to compress the pressure springs and install the two ¾-inch blocks between the release bearing and spring plate hub.

2. Perform the following on Spicer 15½-inch clutch:

a. Insert two 7/16"-14NC (5" long) guide studs into two upper mounting holes of the flywheel.

b. Slide clutch disc aligning tool or a transmission main drive gear, through release bearing sleeve and assemble rear driven disc on tool.

NOTE: When placing driven disc on aligning tool, be sure the larger exposed portion of disc damper springs face the pressure plate (as shown).

c. Place intermediate plate in flywheel ring, aligning driving lugs of plate with slots provided.

d. Place front driven disc assembly on aligning tool with exposed portion of disc damper springs facing the pressure plate.

e. Position clutch assembly under flywheel and use a small chain hoist or jack to lift clutch assembly into position on the two assembly guide studs.

NOTE: If alignment marks were made on flywheel ring and flywheel prior to removal, align

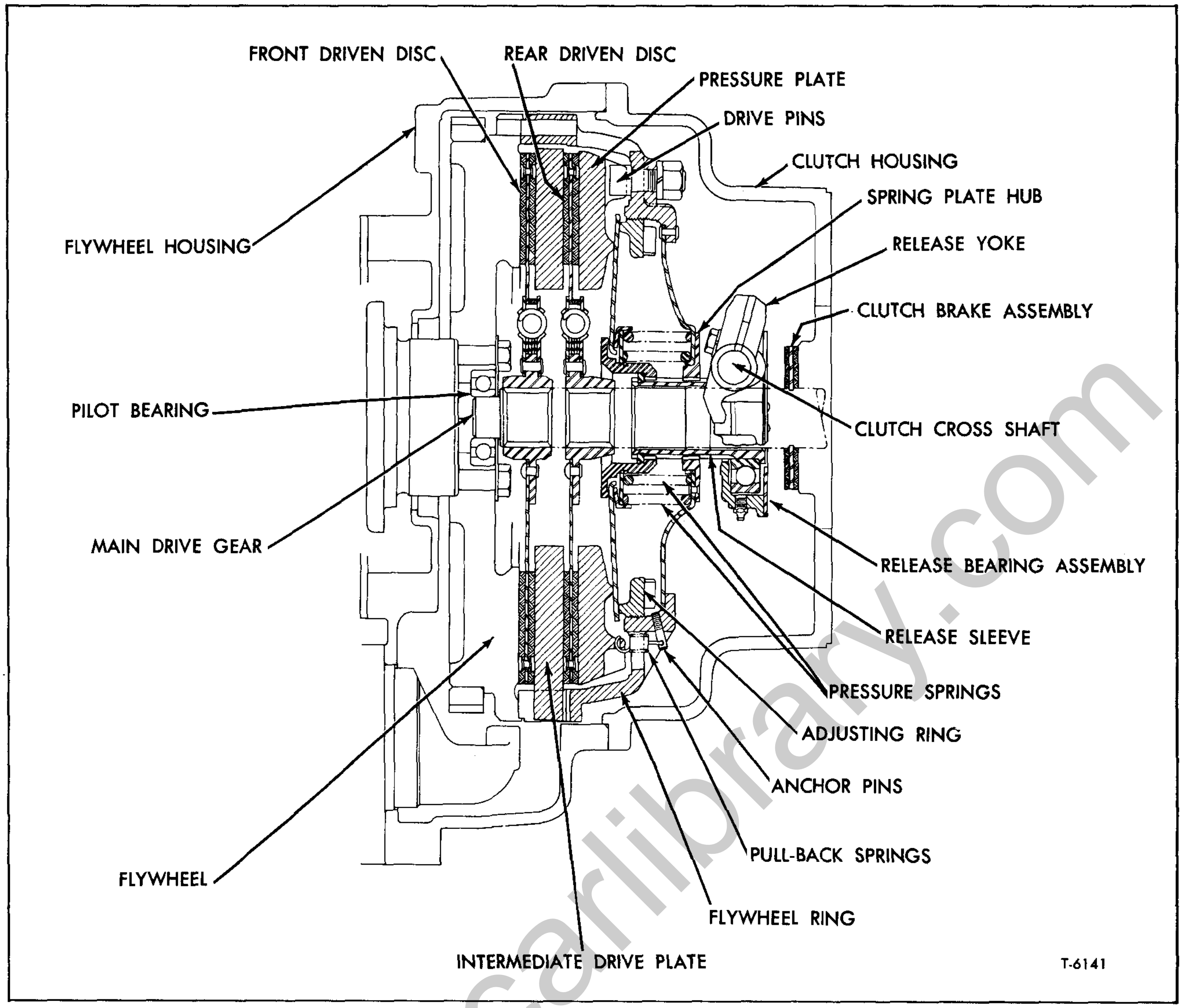


Figure 8—Spicer 15½-Inch Dual Disc Clutch

these before lifting clutch into position on guide studs.

f. Slide clutch assembly forward and position in flywheel pilot. Start ten retaining cap screws with lock washers and run in finger-tight. Tap clutch disc aligning tool in to make sure it has entered and centered in pilot bearing.

g. Remove the two guide studs and insert two remaining cap screws and lock washers.

3. Perform the following on Spicer 14-inch clutch:

a. Place front driven disc in flywheel. Be sure larger exposed portion of disc damper springs face the pressure plate (as shown).

b. Position intermediate drive plate in flywheel, locating the drive slots on the flywheel drive pins.

c. Place rear driven disc in flywheel. Be sure larger exposed portion of disc damper springs face the pressure plate.

d. Position pressure plate and flywheel ring assembly on flywheel and start clutch-to-flywheel cap screws and run in finger-tight.

NOTE: If alignment marks were made on flywheel ring and flywheel prior to removal, be sure these marks are aligned.

e. Insert aligning tool or old transmission main drive gear through the clutch assembly and align front and rear driven disc assemblies. Tap clutch disc aligning tool in to make sure it has entered and centered in pilot bearing.

4. Progressively tighten all cap screws to 35-40 foot-pounds torque.

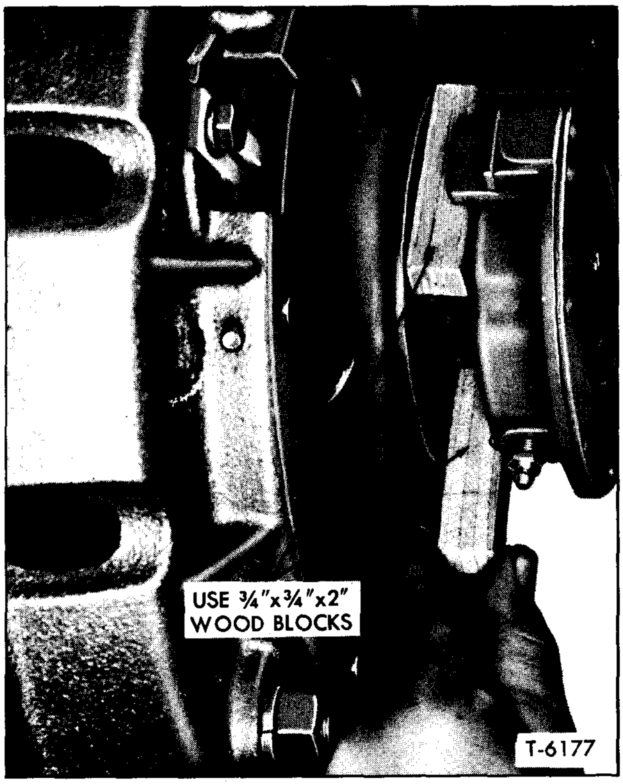


Figure 9—Use of Blocks Between Release Bearing and Spring Plate Hub

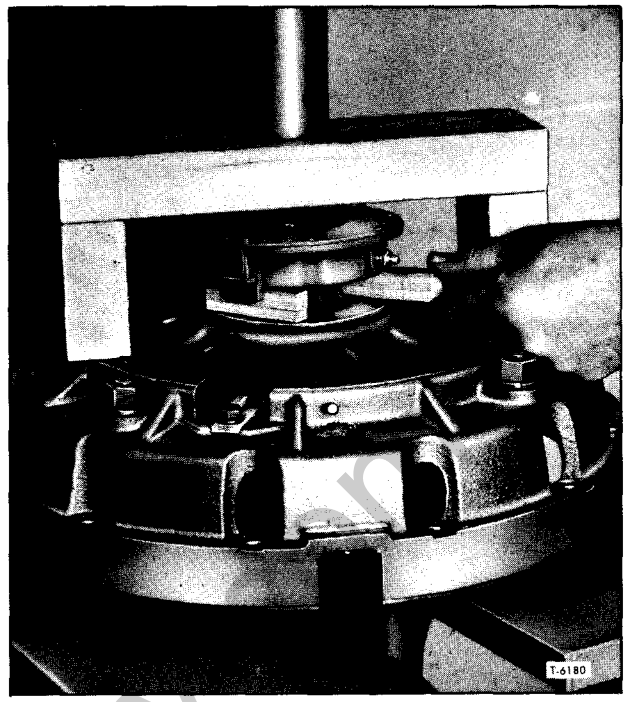


Figure 10—Installing Blocks Between Release Bearing and Spring Plate Hub

CAUTION: DO NOT try to pull the clutch into place by running one cap screw completely down with an impact wrench. This procedure can crack or break the pilot shoulders, causing off-square mounting and out-of-balance conditions.

5. As the cap screws are tightened, the ¾-inch wooden blocks should fall free. If they do not, remove the blocks at this time and the clutch aligning tool.

6. Install clutch brake (fiber washer, steel tang washer, and a second fiber washer) on the transmission main drive gear.

7. Install transmission assembly as described in "TRANSMISSION ON-VEHICLE SERVICE OPERATIONS" (SEC. 7B) of this manual.

8. Adjust clutch controls as described in "CLUTCH CONTROLS" (SEC. 7D) of this manual.

NOTE: Refer to following page for "Troubleshooting Spicer Clutches."

TROUBLESHOOTING
SPICER CLUTCHES

SYMPTOMS AND PROBABLE CAUSE	PROBABLE REMEDY
DRAGGING	
1. Intermediate plate sticking on drive lugs.	1. Free intermediate plate to 0.008"-0.013" clearance.
2. Pressure plate not retracting.	2. Free pressure plate drive lugs to 0.006"-0.010" clearance. Replace pull-back springs.
3. Driven disc distorted or warped.	3. Straighten disc to within 0.015" total indicator reading. Replace disc if this cannot be done.
4. Internal clutch adjustment not correct.	4. Readjust clutch internally and check linkage adjustment.
5. Splines worn on main drive gear of transmission.	5. Replace drive gear and check driven disc hubs for excessive wear. If worn, replace disc. Make sure driven discs slide freely on drive gear splines.
6. Facings gummed with oil or grease.	6. Replace facings or entire driven disc assembly. Cleaning not recommended.
7. Worn clutch release bearing.	7. Replace bearing.
SLIPPING	
1. Weak pressure springs.	1. Replace springs.
2. No "free-pedal."	2. Readjust clutch internally and check linkage adjustment.
3. Worn clutch facings.	3. Replace facings or complete driven disc assembly.
4. Release mechanism binding.	4. Free up mechanism and adjust clutch.
5. Grease or oil on facings.	5. Replace facings or complete driven disc assembly.
NOISY	
1. Clutch release bearing dry or damaged.	1. Lubricate bearing, or replace.
2. Flywheel pilot bearing dry or damaged.	2. Lubricate bearing, or replace.
3. Clutch release bearing housing striking flywheel ring.	3. Adjust clutch. Also check wear on cross shafts, clutch housing bushings and release yoke fingers. If badly worn, replace parts.

FRONT END DRIVE POWER TAKE-OFF

DESCRIPTION

Models JM80 and JI90 have available as optional equipment, provision for a front end drive power take-off as shown in figures 1 and 2.

The front end drive PTO (power take-off) is driven directly from the hub on front of the crankshaft. This option requires a special radiator with a portion of the core removed to allow the PTO (power take-off) propeller shaft to drive directly through the special radiator opening. Additional equipment required is crankshaft hub, fan blade, and attaching parts. The JI90 utilizes a side opening hood. For servicing all front end sheet

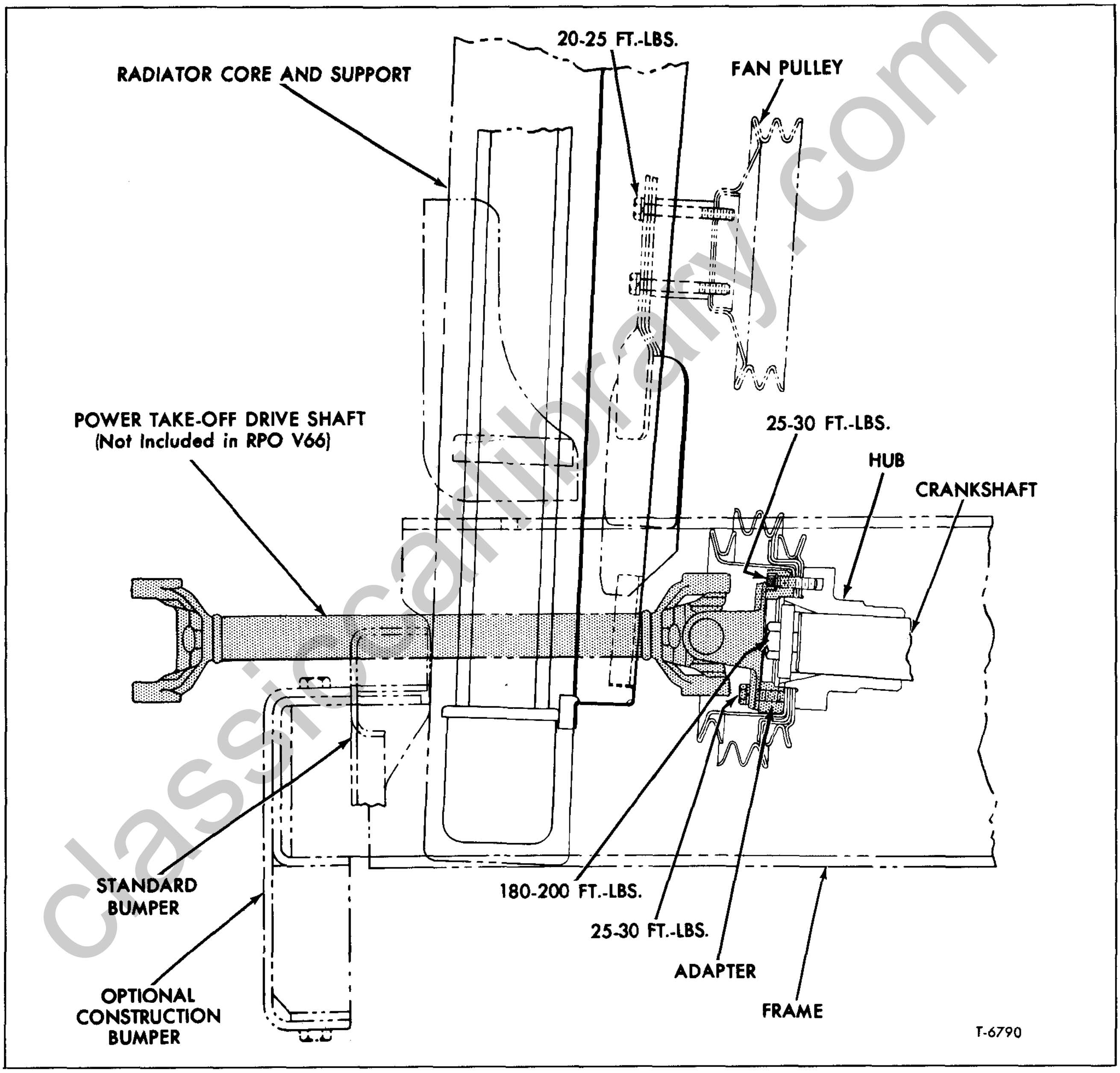


Figure 1—Front End Drive Power Take-Off (JM 80)

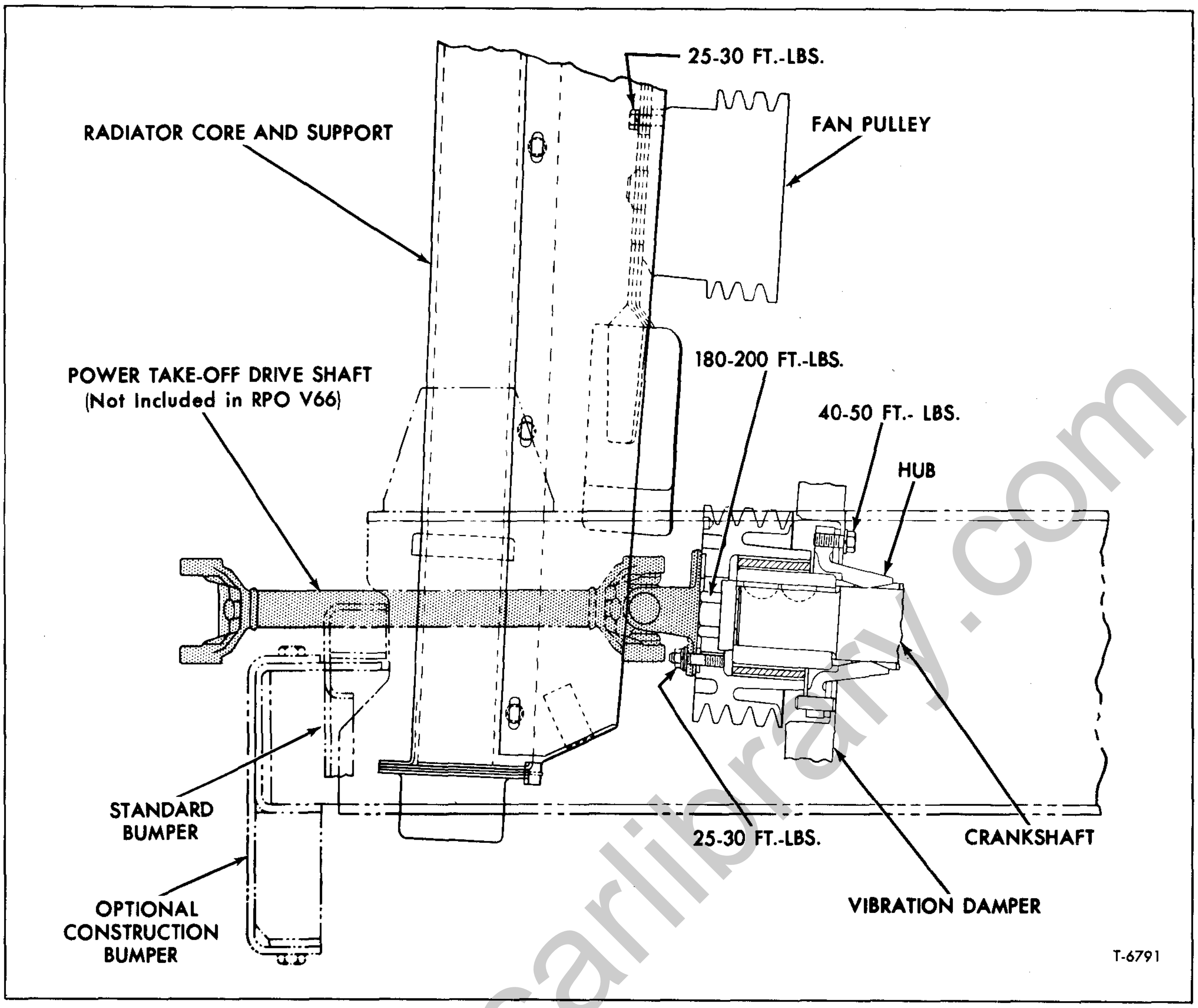


Figure 2—Front End Drive Power Take-Off (J190)

metal refer to SHEET METAL AND FIBERGLASS (SEC. 11) of this manual.

IMPORTANT: It is of utmost importance that engine and radiator mountings must not be allowed to become deteriorated to allow any interference when the PTO is operating.

POWER TAKE-OFF DRIVE REPLACEMENT

(Refer to Figures 1 and 2)

If the PTO drive shaft or universal joints become worn or deteriorated, these components should be replaced as follows:

REMOVAL

1. Disconnect or remove front end mounted power take-off.

2. Remove attaching parts retaining U-joint flange to crankshaft hub. Then, very carefully move PTO drive assembly through radiator opening and remove from vehicle.

3. If necessary to replace crankshaft pulley on the JM 80 refer to GASOLINE ENGINES (SEC. 6A) and for the JI9500 refer to SERIES 53 AND 71 DIESEL ENGINES (SEC. 6C) of this manual.

INSTALLATION

1. Carefully move PTO drive assembly through radiator opening and position U-joint flange against crankcase hub. Be sure to tighten all attaching parts to proper torque as shown in figures 1 and 2.

2. Install and connect front end mounted power take-off to PTO drive assembly. Check for clearance in the area of the PTO drive shaft assembly and correct, as necessary. Check for proper operation of unit and controls.

SECTION 8

FUEL TANK AND EXHAUST

FUEL TANK, LINES, AND GAUGE SYSTEM

FUEL TANK

DESCRIPTION

The standard fuel tank is bracket mounted to the right frame side rail. Tank is secured to tank supports by means of individual metal straps equipped with an adjustable bolt and nut assembly. Metal-to-metal contact between tank, brackets, and straps is eliminated through the use of an anti-squeak material. Mounting brackets are bolted to the frame side rail.

Increased fuel capacity is available by use of optional tanks. Tanks may be cylindrical, step, saddle, or round-type of either steel or aluminum construction. Fabricated steel supports or aluminum brackets are used to secure optional tanks to frame. On some vehicles, the optional 100 gallon tanks have connecting parallel support braces fastened to bottom of the tank brackets. When dual tanks are used, balance hoses are connected between tanks to maintain an equal fuel level in both tanks. Shut-off valves are provided at tank balance line inlet so that one tank of fuel may be held in reserve if desired, or tanks can be removed separately for repairs without necessity of draining both tanks.

Venting of tank is provided for by a vent plug installed at top of tank. A protective guard is welded to tank over vent plug. When replacing the vent plug, make sure arrow on top of vent points toward front of vehicle.

FUEL TANK REPLACEMENT

Draining Fuel Tank (Fig. 1)

The majority of fuel tanks used on heavy-duty truck models incorporate a drain plug. However, the absence of a drain plug makes it necessary to siphon fuel if tank is to be removed.

IMPORTANT: DO NOT attempt to siphon tank using mouth on siphon hose.

NOTE: When dual tanks are used, but only one tank is to be removed, shut off drain cock on opposite tank at balance line; this will eliminate the necessity of draining the opposite tank.

The following procedure for draining fuel from a tank not equipped with a drain plug is recommended:

1. Obtain an 8 to 10 foot length of 3/8", or slightly less, I.D. hose and cut a flap type slit 18 inches from one end.

NOTE: Hose with larger than 3/8" I.D. is not recommended as it is difficult to erect and maintain a siphon using this method with a larger hose.

2. Insert a small nipple (at least 1/8" larger O.D. than the hose I.D.) into opposite end of hose from slit.

3. Insert nipple end of hose into tank until it strikes bottom.

4. With the opposite end of the hose in a suitable container which is positined below bottom of fuel tank, insert an air pressure hose nozzle into flap-type slit and trigger flow of fuel by forcing air pressure through siphon towards container.

Tank Leaks

Before removing fuel tank to correct a leak, careful inspection of tank should be made to determine actual source of leak. "Seam leaks" often turn out to be leaks at filler neck, fuel line connections, or at tank sending unit seal. In such cases, fuel runs down side of tank to flanges and drips off at points along the seam giving a false indication of leaking seams. If careful inspection reveals that tank is actual source of leaks, then remove tank for repairs as required.

IMPORTANT: A leaking fuel tank must be repaired or replaced immediately. In addition to increased operating expense, leaking fuel tanks represent a serious fire hazard. No leakage is permissible anywhere in fuel system lines or tank(s).

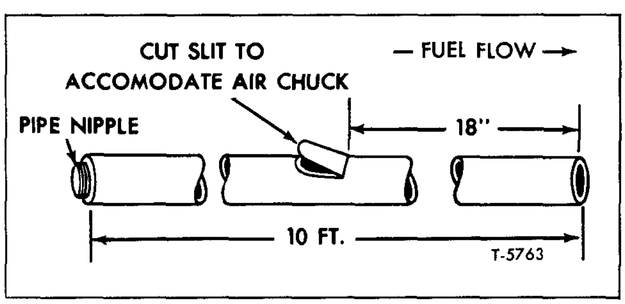


Figure 1—Tank Siphon Construction

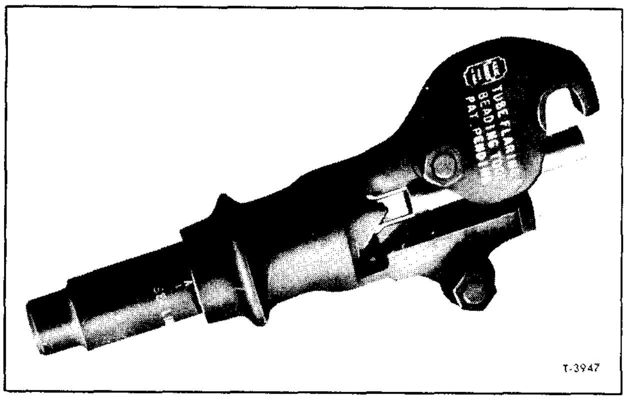


Figure 2—Tube Flaring Tool (J-8051)

Tank Replacement

The following procedure is intended only as a guide and will vary according to truck model and tank type.

1. Drain tank by removing drain plug (if equipped) or using a siphon as described previously.

NOTE: When dual tanks are used, but only one tank is to be removed, shut off drain cock on opposite tank at balance line; this will eliminate the necessity of draining the opposite tank.

2. If tank is equipped with a filler neck hose, loosen lower hose clamp to provide clearance for tank removal.

3. Disconnect fuel line(s) and wiring from tank sending unit. Position or tie fuel lines away from working area, and make sure lines are not kinked. The ignition or control switch must be in "OFF" position.

NOTE: On vehicles where top of tank is not readily accessible, loosen mounting straps enough to disconnect fuel line(s) and wiring.

4. Install jack or suitable support under fuel tank, then remove nuts from tank support strap stud bolts. Carefully remove jack, or blocking, then remove tank from vehicle.

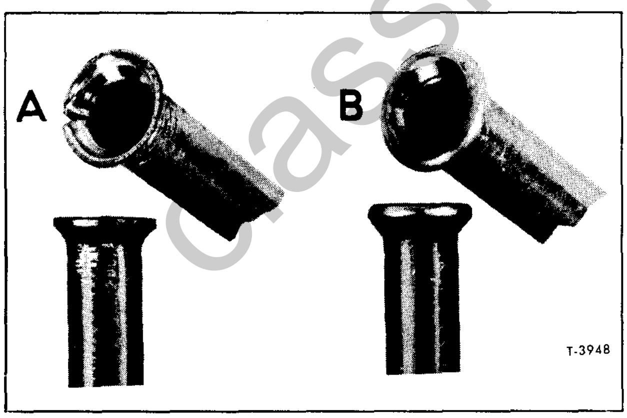


Figure 3—Single and Double Lap Flare

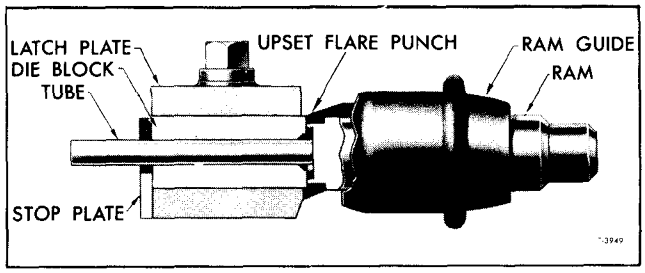


Figure 4—Flaring Operation Positioning Tubing

NOTE: Refer to "Fuel Gauge System" later in this section for procedures applicable to replacing the tank sending unit.

5. To install tank, reverse the removal procedures. Replace all anti-squeak material and be sure mounting straps are properly positioned and strap nuts are evenly tightened to correct torque. Tighten hose fittings only sufficiently to prevent leakage.

CAUTION: Overtightening fuel lines can cause leakage. A fuel line fitting torque chart is located at end of this section.

FUEL LINES

DESCRIPTION

Metal tubing and flexible hoses are used between fuel tank and engine. Following service information applies to both types of lines.

Rigid fuel lines are constructed from steel tubing with inverted flare fittings. Flexible lines are usually plain or fabric covered hose secured by means of hose clamps or threaded couplings.

NOTE: On Series 90 tilt cab models, fuel lines are constructed of Teflon and are sheathed in metallic wire braid. Detachable, re-usable end fittings are used. Hoses may be fabricated to individual desired lengths.

The fuel pickup pipe is generally integral with the tank sending unit. Sending unit wiring terminal and fuel pickup pipe connection is located at top of tank to conform with safety recommendations. A large area, fine-mesh screen is located on bottom of fuel pickup pipe to prevent entrance of dirt or water into the fuel system. Refer to "Fuel Gauge System" later in this section for description of tank sending unit.

STEEL FUEL LINE INSTALLATION

When installing new steel tubing fuel lines, it is important that ends of tubing be properly flared to assure leak-proof couplings. Unless the tubing is properly flared, the couplings will leak.

The tubing must be double-lap flared at the ends in order to produce a strong leak-proof joint.

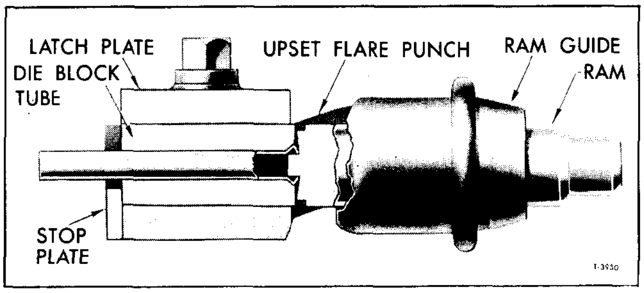


Figure 5—Flaring Operation (First Flare)

The Tool J-8051 (fig. 2) must be equipped with the proper size die block and upset flare punch for each size tubing to form the double-lap flare.

The proper size die blocks and upset flare punches are as follows:

Tubing Size	Die Block	Upset Flare Punch	Finish Flare Punch
3/16"	J-2185-27	J-2185-3	J-2185-26
1/4"	J-2185-28	J-2185-37	J-2185-26
5/16"	J-2185-29	J-2185-4	J-2185-26

NOTE: These special tools are also part of Kit J-8051.

Figure 3 shows two pieces of tubing - one with a single-lap flare "A" and the other with a double-lap flare "B." It will be noted that the single-lap flare splits the tubing while the double-lap flare shown in "B" is a heavy, well-formed joint.

The following procedure should be followed in making up fuel pipes:

1. Cut the tubing to the desired length, using Tool J-8000. Square off ends of tube and ream sharp edges with reamer tool provided on the tube cutter.
2. Install compression couplings on tubing and dip end of tubing to be flared in hydraulic brake fluid. This lubrication results in better formation of the flare.
3. Select the correct size upset flare punch. One end of this punch is hollowed out to gauge the amount of tubing necessary to form a double-lap flare.
4. Slip the punch into the tool body with the gauge end toward the die blocks, install the ram and tap lightly until the punch meets the die blocks and they are forced securely against the stop plate (fig. 4).
5. Draw latch plate nuts down tight to prevent tube from slipping. Draw nuts down alternately beginning with nut on closed side to prevent distortion of plate.
6. Remove punch and ram. Reverse punch and place back in tool body. Install ram and tap lightly until face of punch contacts face of die blocks to complete first flare operation (fig. 5).

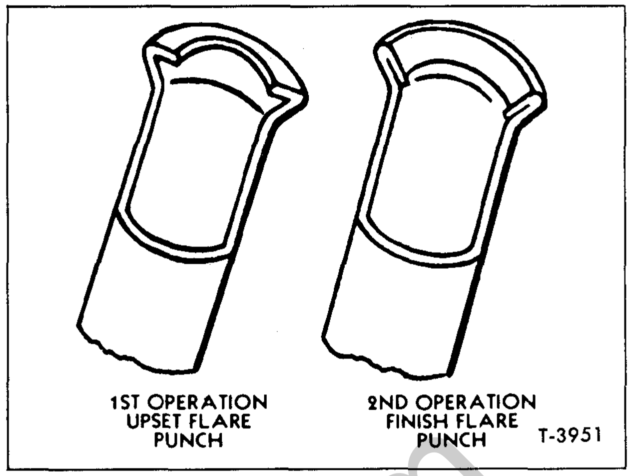


Figure 6—Flaring Operation (First and Second Flare)

7. Remove ram and punch.
8. Insert finish flare and ram in tool body and tap ram until a good seat is formed (fig. 6).
9. Blow tubing out with compressed air.

CAUTION: When tightening nut on tubing tighten only to a point sufficient to prevent leakage.

IMPORTANT: After flaring steel tubing, passages must be free of burrs, cuttings, and dirt. Before installing new fuel line on vehicle, be sure to clear passages with compressed air.

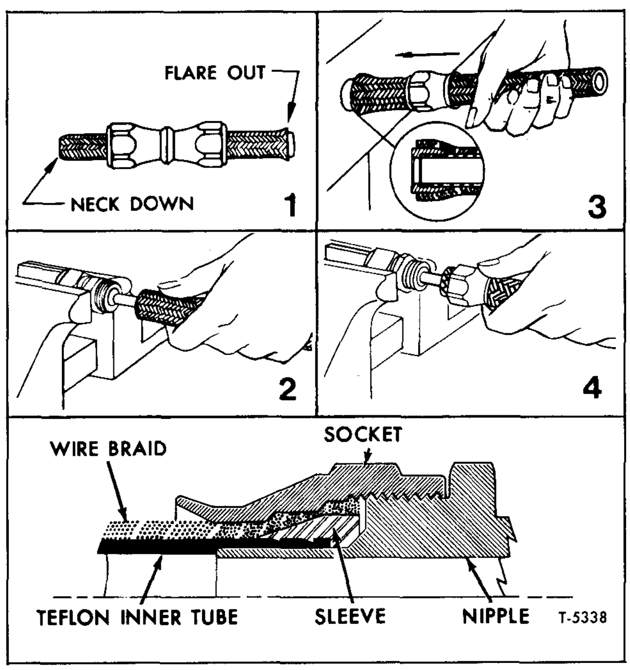


Figure 7—Teflon Hose Assembly

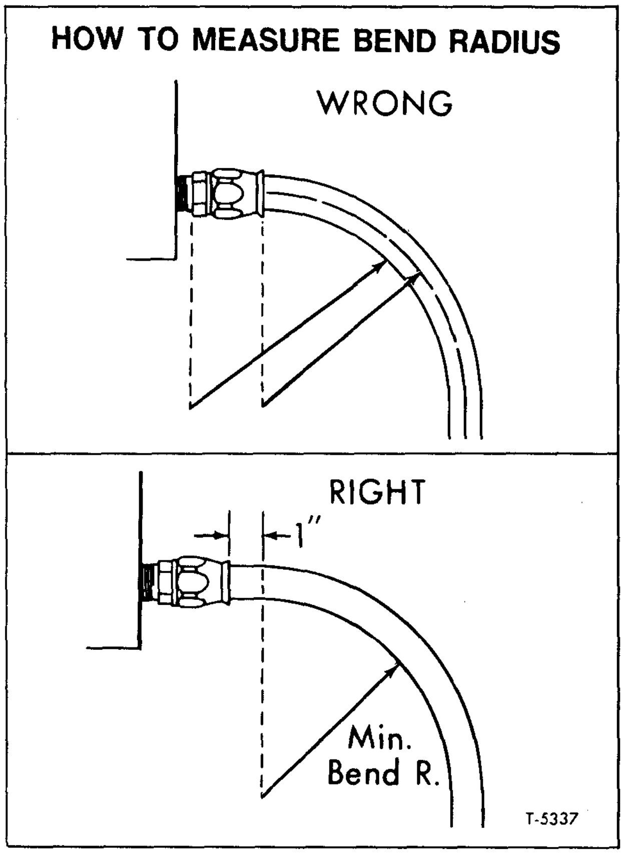


Figure 8—Installation of Teflon Hose to Insure Proper Bend Radius

When installing either rigid or flexible fuel lines with threaded couplings, tighten nuts only enough to prevent leakage and provide a secure connection. Where possible, a back-up wrench should be used to prevent twisting or excess stress on fuel line. DO NOT OVER-TIGHTEN.

Fuel lines should be inspected occasionally for leaks, kinks, or dents. Dented, kinked, or cracked fuel lines must be replaced. If seepage at connections cannot be corrected by tightening, fittings and lines must be replaced.

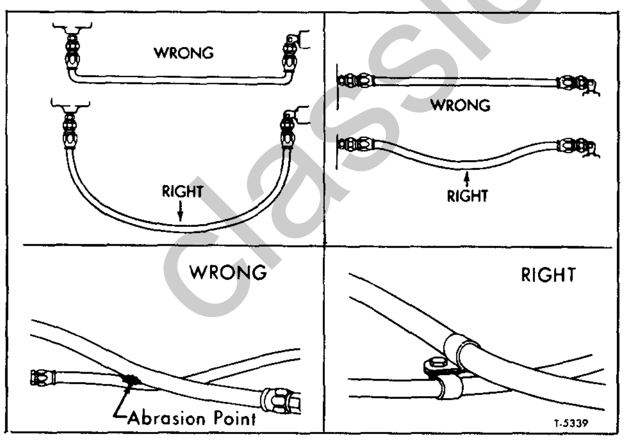


Figure 9—Proper Installation of Teflon Hose

If contaminants are found in fuel filters, or evidence of clogging is indicated, disconnect suspected line at both ends and blow out with compressed air. If passage cannot be cleared of obstructions, replace with new line. A clogged strainer on tank pickup pipe can result in fuel starvation. Clean or replace as required. DO NOT omit strainer.

When replacing a flexible fuel line, be sure hose is properly located to prevent chafing against frame members. Fuel line retainers should be positioned properly on fuel lines to assure secure support yet not result in line constriction. Cracked, corroded, or bent retainers should be replaced.

TEFLON HOSE REPLACEMENT

Disassembly

Refer to figure 7 for sectional view of teflon hose.

1. Unscrew and remove the nipple.
2. Slide the socket back on the hose by tapping against a flat surface.
3. Remove the sleeve from the teflon hose with pliers.

Assembly

Refer to figure 7 for sectional view of teflon hose.

1. Wrap hose with masking tape at cut-off point and cut squarely to length through the taped area using a sharp cut-off wheel or a fine-toothed hacksaw.
2. Remove tape and trim any loose wires flush with the tube stock. Any burrs on the bore of the tube stock should be removed with a knife. Sometimes wire braid will tend to "neck down" on one end and "flare out" on the opposite end. This is a characteristic of wire braid hose and can be used to an advantage in the assembly of the fittings (item 1, fig. 7).
3. Slip two sockets back-to-back over the "neck down" end of the hose. Position the sockets approximately 3 inches from each end (item 1, fig. 7).
4. Mount nipple hex in a vise. Work the hose bore over the nipple to size the tube and aid separating the braid from the teflon inner tube. Remove the hose from the nipple (item 2, fig. 7).
5. Push the sleeve over the end of the inner tube and under the wire braid by hand. Complete positioning of the sleeve by pushing the hose end against a flat surface (item 3, fig. 7).
6. Visually inspect to see that the tube stock butts against the inside shoulder of the sleeve. Set the sleeve barbs into the teflon tube by pushing a

tapered punch into the end of the sleeve and the tube.

7. Lubricate nipple and socket threads (for stainless steel fittings, use carbon tetrachloride; other material combinations use standard petroleum lubricants).

8. Hold nipple hex in a vise. Push the hose over the nipple with twisting motion until seated against the nipple chamfer (item 4, fig. 7).

9. Push socket forward, and hand-start threading of socket to nipple. Wrench-tighten nipple hex until clearance with socket hex is 1/32" or less. Tighten further to align corners of the nipple and socket hexes.

Hose Installation

1. Attach end of hose to most inaccessible end of its routing. Tighten connection finger tight so that the hose is free to turn during installation.

2. Attach the other end of hose in the same manner.

3. If the hose line is not tightened sufficiently, loosen the swivel (female) end before tightening the male end.

4. Properly orient the hose along its routing and install the required line support clamps.

5. Do not exceed minimum bend radius during handling, storage, or installation. If the bend radius is exceeded, the hose will tend to flatten and kink. Having an adequate bend radius will help prevent collapsing of the line or restriction of flow as shown in figure 8.

6. When installing, the assembly should be positioned so that the flexible portion of the hose extends at least one and one-half times the hose diameter before the bend of the hose as shown in figure 8.

7. Remember the hose will change in length when pressurized. Provide slack or bend in the hose to compensate for any changes which might occur as shown in figure 9.

8. Rotate and clamp hose to prevent it from contacting another hose line or abrasion point as shown in figure 9.

CAUTION: In securing the line support clamps, care should be exercised in distributing hose slack between the hose connections and the clamps. Do not bend or force the hose to a sharp angle at any location. Be sure that gradual curves are used for all routing. Installation of clamps must never pinch the hose line or cause it to be subjected to tension, torsion, compression or sheer stress. Installation of undersize or oversize hose support clamps must be avoided.

9. Tighten the fitting connection and clamps.

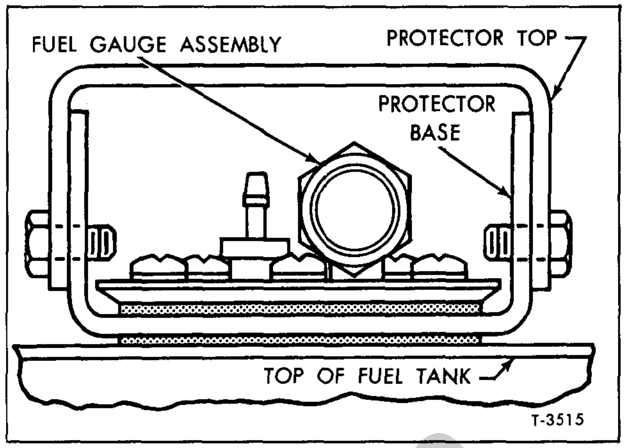


Figure 10—Fuel Gauge Protective Cover

FUEL GAUGE SYSTEM

TANK UNIT

The fuel tank strainer, fuel pickup pipe, and tank gauge unit comprise a complete assembly. The fuel tank gauge unit is mounted on top of fuel tank. The large area fuel strainer is of sufficiently fine mesh to prevent entrance of contaminants into fuel system and operates with a self-cleaning action. Inspect condition of strainer whenever tank unit is removed and replace or clean as required.

A protective top (fig. 10) is used on some models to shield the fuel gauge assembly. The tank unit (fig. 11 or 12) houses a variable resistor (rheostat) which controls the flow of current through the dash gauge according to position of the float.

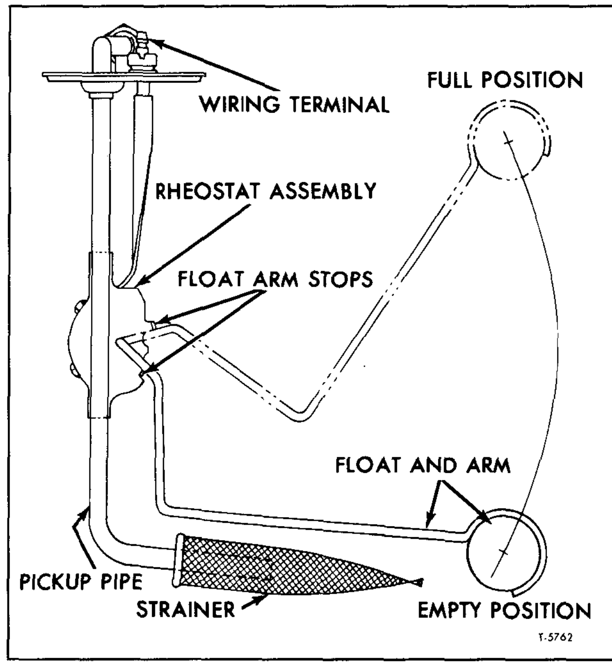


Figure 11—Fuel Gauge Sending Unit (Typical)

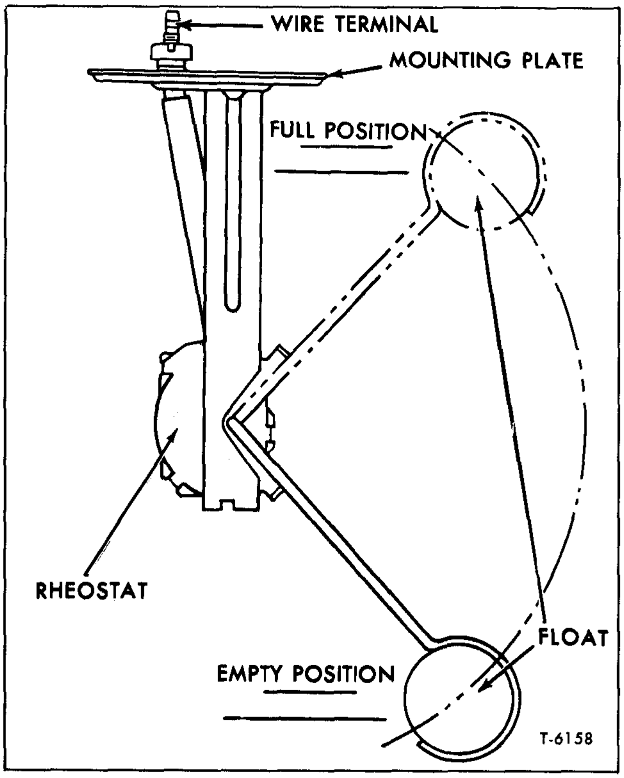


Figure 12—Fuel Gauge Assembly (Typical)

The tank unit rheostat may be checked for accuracy with an ohmmeter. With float in "EMPTY" position, on ohmmeter connected across the rheostat should indicate 0 to 1.0 ohm resistance except on Series 70 through 90 tilt cab models which should indicate 0 to 0.5 ohm resistance. With float in "FULL" position, resistance should measure approximately 90 ohms except on Series 70 through 90 tilt cab models which should measure approximately 30 ohms resistance.

As the tank is filled, the tank unit float arm will rise to increase rheostat resistance which in turn will cause the pointer in dash gauge to move toward the "FULL" position.

Fuel Gauge Removal (Fig. 13)

1. Place ignition or engine control switch in "OFF" position.
2. Remove two cap screws which retain gauge protector top to base. Remove protector top.
3. Disconnect feed wire from terminal on gauge unit. Remove screws which attach gauge to tank.
4. Pry gauge, protector base, and gasket loose from tank. Lift assembly from tank and maneuver float through tank opening.
5. The protector base plate can be separated from gauge by prying base loose from gauge and gasket. Base can then be removed over the rheostat and float.

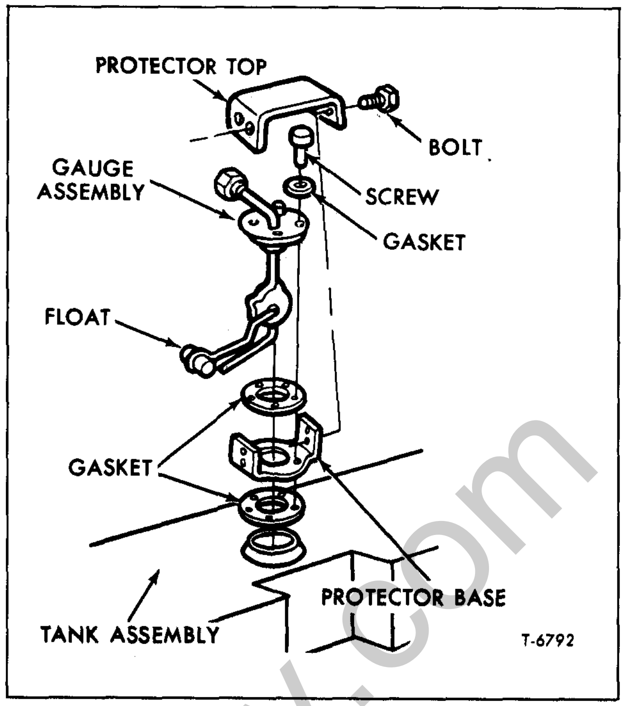


Figure 13—Fuel Gauge Mounting (Typical)

DASH GAUGE

The dash fuel gauge is an electromagnetic instrument which visually indicates the quantity of fuel in tank when the ignition or control switch is turned to the "ON" or "IGNITION" position.

The dash gauge consists of a permanent magnetic armature and spindle assembly to which a pointer is attached. Surrounding the magnetic armature are two coils wound perpendicular to each other. These coils provide the magnetic field which deflect the armature and pointer. The intensity and direction of the resultant magnetic field of the coils is dependent on current flow controlled by resistance of the tank unit rheostat. When the position of the slider arm varies due to float action, a change in rheostat resistance occurs which results in a proportional current change in the dash gauge coils. This allows the armature (and pointer) to align itself according to the resultant magnetic field produced by the coils. The total angular travel of armature and pointer from "EMPTY" to "FULL" is 90 degrees.

As mentioned previously, the tank unit rheostat resistance is approximately zero ohms when the fuel tank is empty (float arm is at its lowest position). As the tank is filled, the tank unit float arm will rise to increase rheostat resistance which in turn, will cause the pointer in the dash gauge to deflect towards the "FULL" position.

The dash gauge fixed calibration resistor shown on Wiring Diagram in "Trouble Diagnosis Chart" later in this section is connected across the two external wiring terminals of the dash gauge. Refer to CHASSIS ELECTRICAL AND INSTRUMENTS (SEC. 12) for illustrations of dash fuel gauge as positioned on various types of instrument clusters.

FUEL TANK SELECTOR SWITCH

A fuel tank selector switch, used as optional equipment on some vehicles, is mounted on the dash panel. The rocker type switch is connected in series with a left and right fuel tank gauge unit and the fuel gauge on instrument panel. To determine the quantity of fuel in either tank, position switch in left- or right-hand tank position. Pressing on upper portion of switch registers right tank, and lower portion the left tank.

TROUBLE DIAGNOSIS OF GAUGE SYSTEM

Refer to "Fuel Gauge System Trouble Diagnosis Chart" later in this section for probable causes of trouble and suggested remedies for repair of fuel gauge system.

If tank sending unit or dash fuel gauge has become defective internally, the only effective remedy is to replace the inoperative unit.

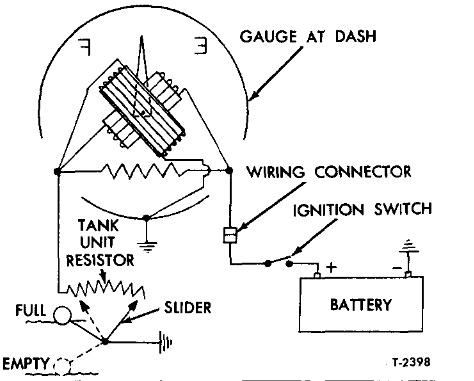
> IMPORTANT: Conventional cab models and Series 90 tilt cab models have a 90 ohm dash gauge and a 90 ohm tank sending unit. Series 70 through 80 tilt cab models have a 30 ohm dash unit and a 30 ohm tank sending unit. It is important that dash gauge and sending units not be interchanged between models. If incorrect fuel gauge components are installed, inaccurate fuel quantity readings will result. To be certain that mating resistance between dash gauge and tank unit are maintained, be sure to install correct parts as listed in current Chevrolet Master Parts Book.

FUEL TANK AND LINE TORQUE SPECIFICATIONS

APPLICATION	TORQUE FT. LBS.
Hose Line Clip Bolt Nut	25-30
Hose Line Clip Bolt (To Hose Cross Support Brace) (Nut)	8-10
Protector Top to Base Bolt	8-10
Tank Mounting Strap to Running Board Mounting Bracket Stud Nut	8-10
Tank Mounting Strap to Bracket Stud Nut (With 37 Gallon Fuel Tank)	30-40
Tank Mounting Strap to Bracket Stud Nut (Except 37 Gallon Fuel Tank)	50-60
Tank Mounting Bracket to Frame Bolt Nut (With 37 Gallon Fuel Tank)	70-80
Tank Mounting Bracket to Frame Bolt Nut (Except 37 Gallon Fuel Tank)	90-110
Tank Cross Support Brace to 100 Gallon Tank Mounting Bracket Bolt Nut	50-60
Teflon Hose Fittings	Tighten Fittings Only Sufficiently to Prevent Leaking.

Refer to Next Page For
"Fuel Gauge System Trouble Diagnosis Chart."

FUEL GAUGE SYSTEM TROUBLE DIAGNOSIS CHART



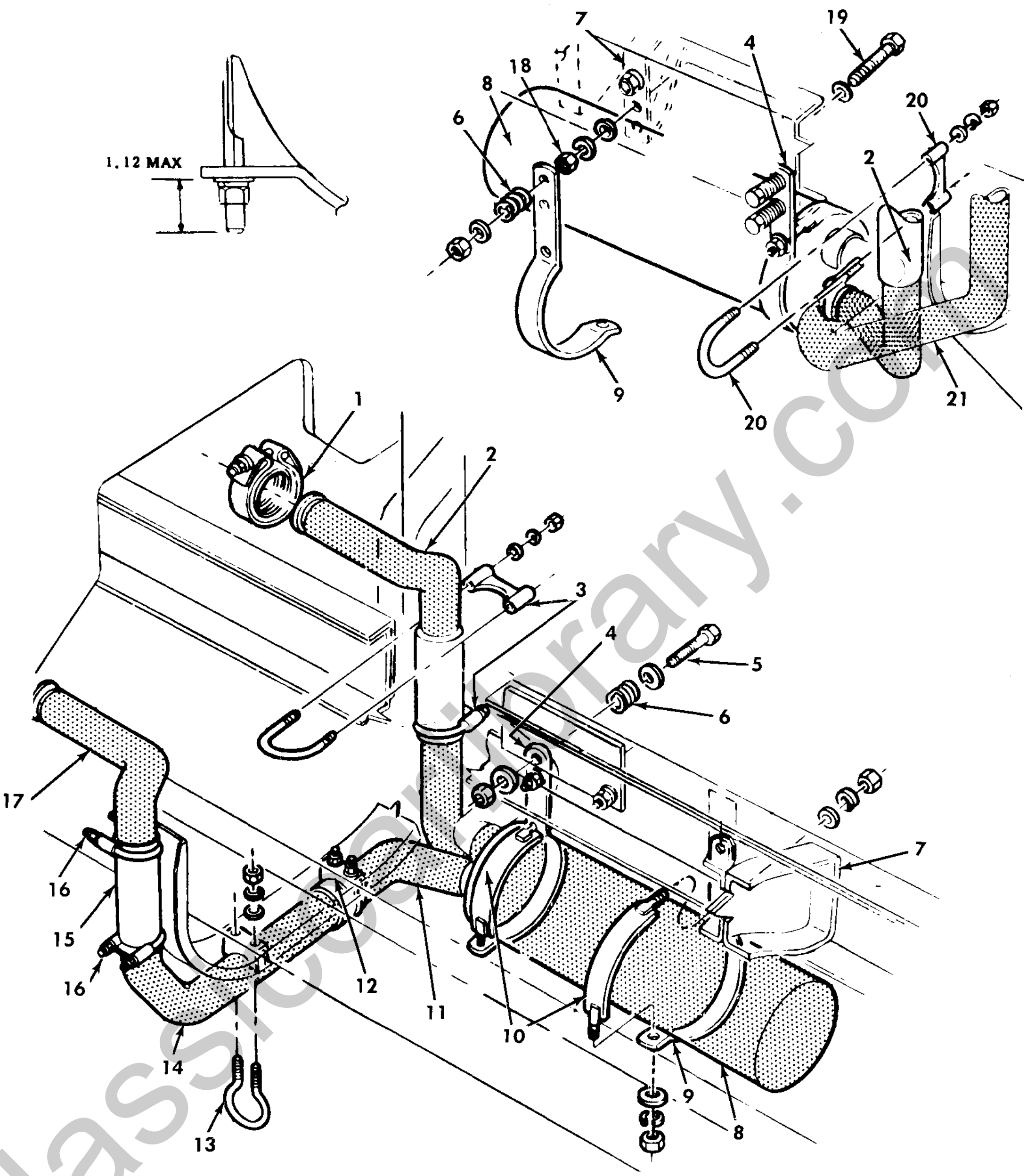
Fuel Gauge System Wiring Diagram

POSSIBLE COMPLAINT

PROBABLE CAUSE	Reads 1/4 when empty or won't read empty	Reads accurately between "E" and 1/4; above 1/4 reads "F"	Needle does not move	Reads "E" all the time	Reads "F" all the time	Reads 3/4 when full or won't read full	Reads 1/4 when full	Reads too high for amount in tank	Erratic reading	SUGGESTED REMEDIES
1. Loose connection anywhere in circuit									x	Inspect and, if necessary, clean and tighten all connections in circuit
2. Poor dash fuel gauge calibration								x		Install new dash fuel gauge
3. Poor tank unit calibration								x		Install new tank unit*
4. Circuit grounded in resistor of tank unit						x	x			Install new tank unit*
5. Circuit grounded between tank unit resistor and dash gauge				x						Insulate grounded circuit
6. Circuit within dash gauge grounded.								x		Install new dash fuel gauge
7. Circuit grounded between battery and dash gauge.			x							Insulate grounded circuit
8. Open circuit between ignition switch and dash gauge			x							Clean and tighten appropriate terminals or repair broken wire
9. Open circuit between ground terminal on gauge and ground				x						Clean and tighten mounting bracket where contact is made between dash gauge and ground
10. Open circuit between sending unit terminal on dash gauge and resistor terminal on tank unit					x					Clean and tighten appropriate terminals or repair broken wire
11. Open circuit in resistor of tank unit at 1/4 full position		x								Install new tank unit*
12. Open circuit between tank unit slider resistor and ground					x					Install new tank unit*
13. Needle rubbing on face of gauge			x	x	x	x	x			Position needle to prevent contact with face or install new gauge
14. Fuel tank float hang-up	x		x	x	x	x	x			Free binding float or install new tank unit*
15. Top of fuel tank deformed						x				Straighten tank top or replace tank
16. Bottom of fuel tank deformed	x									Straighten bottom of tank or replace tank
17. Tank unit mounting flange bent	x					x	x			Straighten mounting flange or replace tank unit*

* Ignition switch must be "OFF" before removing tank sending unit, otherwise full battery voltage may destroy unit or ignite fuel vapors. For maximum safety, remove cable from negative battery terminal.

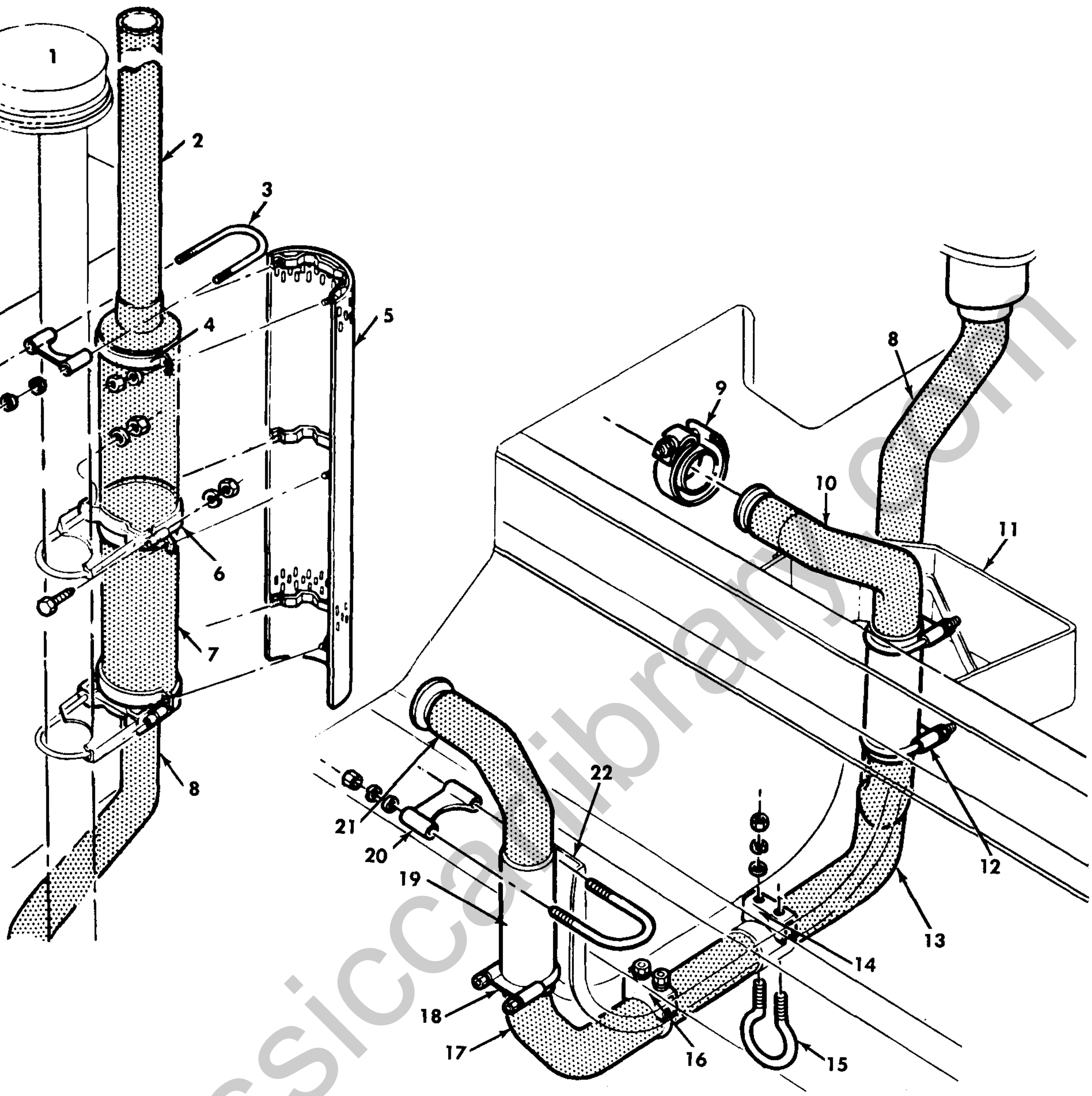
EXHAUST SYSTEM



1 Exhaust Pipe to Manifold Clamp
2 Exhaust Pipe
3 Clamp
4 Muffler Strap
5 Bolt
6 Spring
7 Crossmember
8 Muffler
9 Muffler Strap
10 Muffler Strap Band
11 Crossover Pipe
12 Crossover Pipe Support Clamp
13 U-Bolt
14 Exhaust Pipe
15 Flexible Coupling
16 Clamp
17 Exhaust Pipe
18 Nut
19 Bolt (Combination Frame Crossover and Strap)
20 Clamp
21 Tail Pipe

T-6116

Figure 1—Horizontal Muffler and Vertical Tail Pipe (Typical)



1 Air Cleaner and Tube Assembly	7 Muffler	15 Clamp U-Bolt
2 Upper Tail Pipe	8 Lower Tail Pipe	16 Support Clamp
3 Muffler Clamp	9 Exhaust Pipe Clamp	17 Exhaust Pipe
4 Shield Clamp Band	10 Exhaust Pipe	18 Clamp
5 Shield	11 Frame Bracket	19 Flexible Coupling
6 Muffler to Air Cleaner Tube Clamp Assembly	12 Clamp	20 Clamp
	13 Crossover Pipe	21 Exhaust Pipe
	14 Support Clamp	22 Crossmember

T-6117

Figure 2—Vertical Muffler and Tail Pipe (Typical)

Exhaust system configurations vary according to the type of engine and model designation. A typical horizontal and vertical muffler installation is illustrated in figure 1 or 2. In general, exhaust system connections are of split joint coupled design secured with clamps and bolts. Flexible hangers are used to reduce noise transfer to body and to relieve concentrated loads on exhaust system components.

On Series 90 tilt cab models, exhaust and tail pipes are formed tubes which are designed to fit chassis contours, and are fastened at joints and connections with U-bolt type clamps. Crossover pipes are bracket-fastened to the frame cross-member for support.

Mufflers are of heavy duty construction with aluminized tubes and baffles.

MAINTENANCE

EXHAUST RESTRICTION AND LEAKS

Exhaust system should be inspected periodically for restrictions and leaks. Restrictions such as kinked or crimped pipes result in excessive back pressure which can lead to increased fuel consumption, power loss, and possible damage to engine combustion chamber components. Exhaust leaks are commonly the result of loose clamp bolts, defective exhaust pipe to manifold packing, corroded pipes, or a punctured muffler. In addition to objectionable noise, a leaking exhaust system could allow toxic gases to enter cab.

Damaged or corroded exhaust system components should be replaced without delay. If it is absolutely necessary to operate vehicle when an exhaust leak exists, use extreme caution and keep cab well ventilated.

EXHAUST SYSTEM ALIGNMENT

During installation of a new exhaust pipe, muffler or tail pipe, care should be taken to properly position components in relation to each other. Particular care should be given to the installation of the exhaust pipe and crossover pipe assembly on "V" engines equipped with single exhaust system.

Incorrectly assembled parts of exhaust system are frequently the cause of annoying noises and rattles due to improper clearance. Therefore, leave all clamp bolts and muffler strap bolts loose temporarily until the entire system has been inspected to determine if there is adequate clearance between exhaust components and frame members. The weight of the exhaust system should be properly distributed on all supporting brackets and hangers. If the load is not properly balanced, reposition pipes at connecting joints to relieve any concentrated loads. After adjusting hangers, aligning pipes, and repositioning muffler, check entire system for adequate clearance and then tighten all clamps, working from front to rear. Start engine and inspect all connections for leakage.

On all exhaust and tail pipe clamp installations locate centerline of clamp to end of slot in pipe as shown.

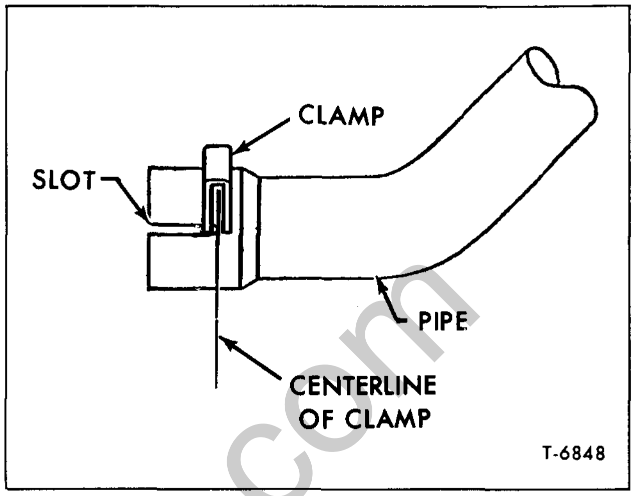


Figure 3—Exhaust Pipe Clamp Installation

The exhaust pipe clamps must be installed over slots in exhaust pipes as shown in figure 3.

NOTE: When installing exhaust pipe to manifold, always use new packings and nuts. Be sure to clean manifold stud threads with a wire brush before installing new nuts.

CAUTION

If a gasoline engine is operated with a faulty exhaust system, poisonous (carbon monoxide) gas may enter cab and cause serious or fatal injury to personnel. Carbon monoxide may or may not have a detectable odor, and is tasteless and colorless. In the presence of carbon monoxide, physical symptoms such as headache, eye smarting and/or drowsiness may be experienced.

When working on fuel system, fire fighting and appropriate safety equipment should be provided in accordance with local fire and safety regulations.

Before making adjustments on Fuel System Units, be sure Electrical System is functioning properly.

WARNING - CARBON MONOXIDE

Keep cowl vent and heater intakes closed when operating in congested traffic to prevent deadly exhaust gases from entering cab.

SECTION 9

STEERING SYSTEM

Contents of this section are listed in Index below:

NOTE: Illustrations are numbered consecutively within each sub-section.

MECHANICAL STEERING

MODEL APPLICATION CHART

TRUCK SERIES	GEAR MODEL	RATIO
Series 70/90 Conventional Cab Models	555-D-38	28.14:1
Series TV70/TM80	553-D-17	28.14:1
Series 90 Aluminum Tilt Cab Models	555-D-37	28.14:1
OPTIONAL		
Series TV70/TM80	568-D-45	30.51:1

GENERAL

Rotation of the steering wheel is transmitted to the front axle right and left steering arms from the steering gear Pitman arm by linkage consisting of rods and levers.

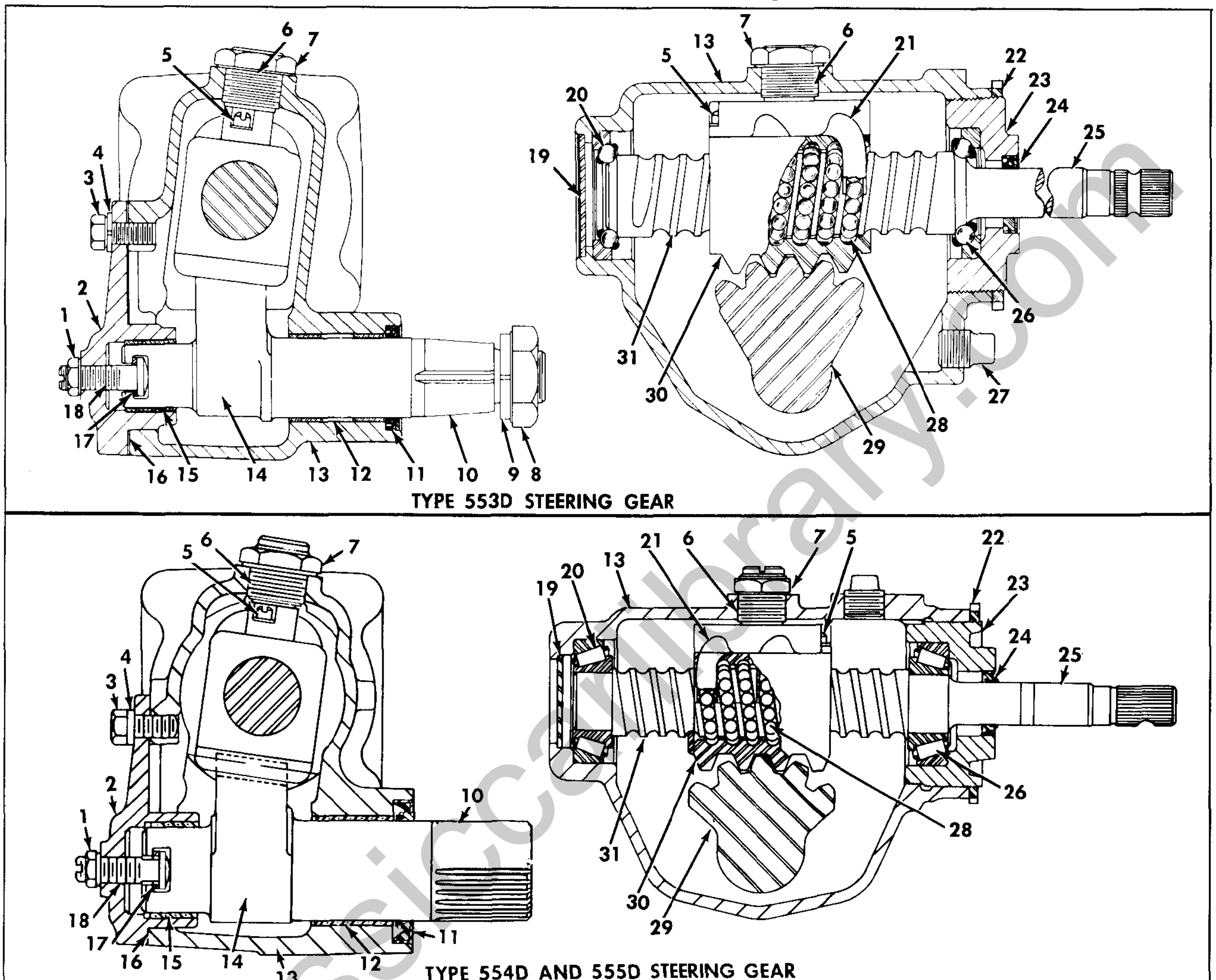
A recirculating ball bearing and sector nut type steering gear, mounted on left frame side rail forward of front wheels, is used on all vehicles covered by this manual.

Steering gear assemblies, while similar in construction, vary in size and mounting, depending on truck model application. Refer to "Model Application Chart" previously.

The major differences in the steering gear assemblies are described in the following text.

NOTE: Refer to "Steering Gear Adjustments" later in this section for adjustment of Pitman shaft lash, back-up adjuster, and worm thrust bearings.

The type 553-D and 555-D steering gear assemblies shown in figure 1 have an adjuster assembly at shaft end of gear housing for adjustment of worm thrust bearing; lip type oil seals at steering worm and Pitman shaft; shims for adjustment of Pitman shaft lash, and bushings in gear housing and side cover. A back-up adjuster is used on some steering gears to prevent the worm shaft from flexing up and down.



1 Lash Adjuster Lock Nut	12 Housing Bushing	22 Adjuster Lock Nut
2 Side Cover	13 Steering Gear Housing	23 Cup and Adjuster Assembly
3 Side Cover Bolt	14 Pitman Shaft Sector Gear	24 Adjuster Worm Thrust Bearing Oil Seal
4 Lock Washer	15 Side Cover Bushing	25 Steering Shaft
5 Clamp Retainer Screw	16 Side Cover Gasket	26 Upper Worm Thrust Bearing
6 Back-up Adjuster *	17 Lash Adjuster Shim	27 Filler Plug
7 Back-up Adjuster Lock Nut *	18 Lash Adjuster	28 Worm Balls
8 Pitman Arm Nut	19 Expansion Plug	29 Pitman Shaft Sector Gear
9 Lock Washer	20 Worm Thrust Bearing	30 Ball Nut
10 Pitman Shaft	21 Ball Guide	31 Worm Shaft
11 Pitman Shaft Oil Seal	*Some Models	T-6900

Figure 1—Type 553-D and 555-D Steering Gear (Typical)

The 568-D steering gear assemblies shown in figure 2 have needle bearings in the gear housing and side cover. Shims are provided between the housing and end cover or housing and top cover for adjustment of worm thrust bearings. Packing and retainer is used in gear housing at Pitman shaft end. "Stops" are countersunk at each end of worm portion of shaft to prevent worm nut from bottoming on extreme turns. A back-up adjuster is used, on some models, to keep worm shaft from flexing.

STEERING GEAR MAINTENANCE

The following maintenance operations may be accomplished with the steering gear assembly installed in the vehicle:

1. At regular intervals, check and if necessary tighten all steering gear mounting bolts, Pitman arm nut, and gear housing upper cover and side cover attaching bolts.
2. Lubricate the steering gear and related linkage as described in LUBRICATION (SEC. 0).
3. Adjust linkage and steering gear assembly whenever looseness in steering gear indicates adjustment is required. Refer to "Steering Gear Adjustments" and "Steering Linkage" later.

STEERING GEAR ADJUSTMENTS

The steering gear assembly is designed to provide adjustment to compensate for normal wear at worm bearings, Pitman shaft, and mating parts.

Before adjustments are made to the steering gear in an attempt to correct such conditions as shimmy, loose or hard steering and road shocks, a careful check should be made of front end alignment, shock absorbers, wheel balance, and tire pressure for possible causes.

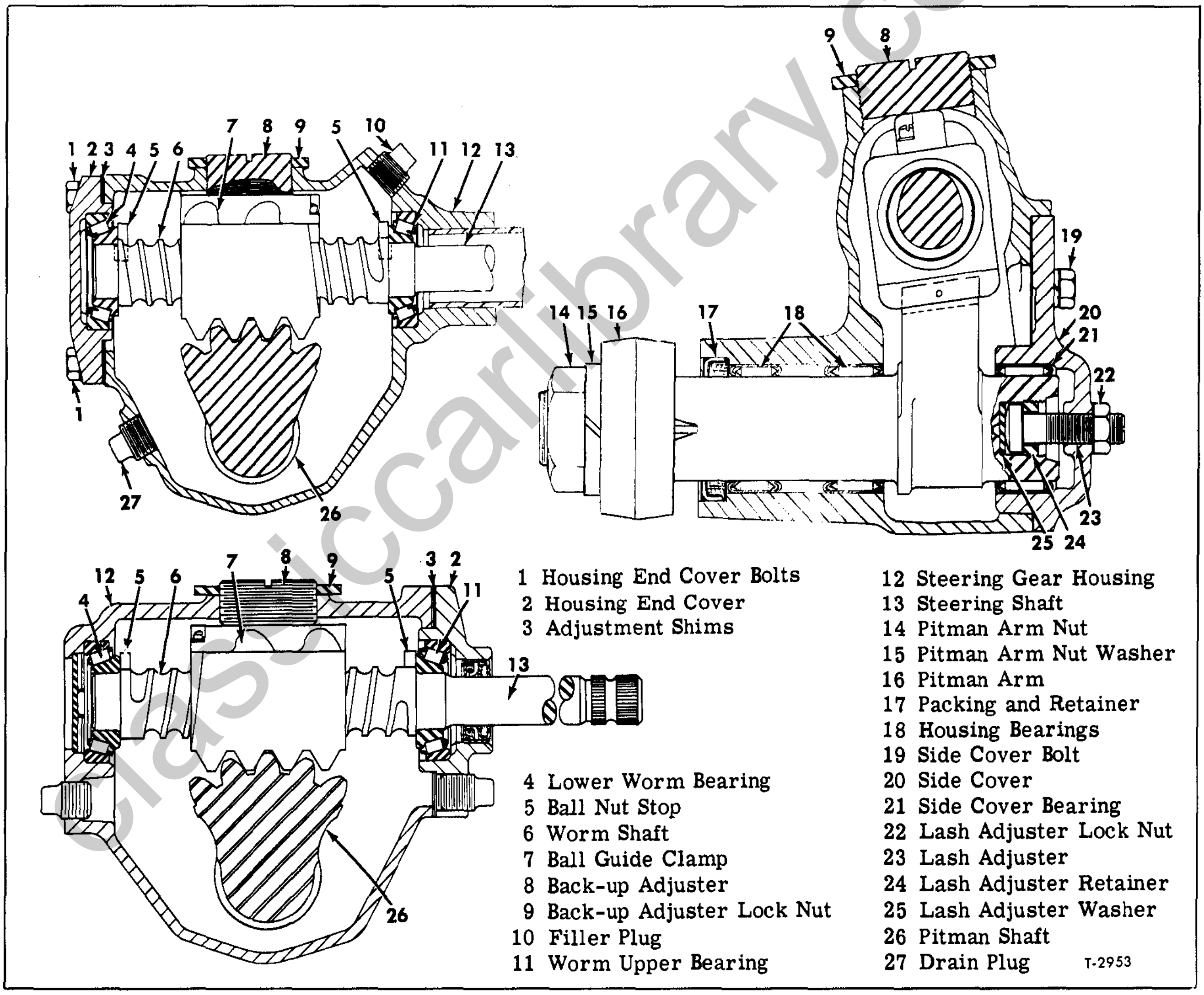


Figure 2—Type 568-D Steering Gear (Typical)

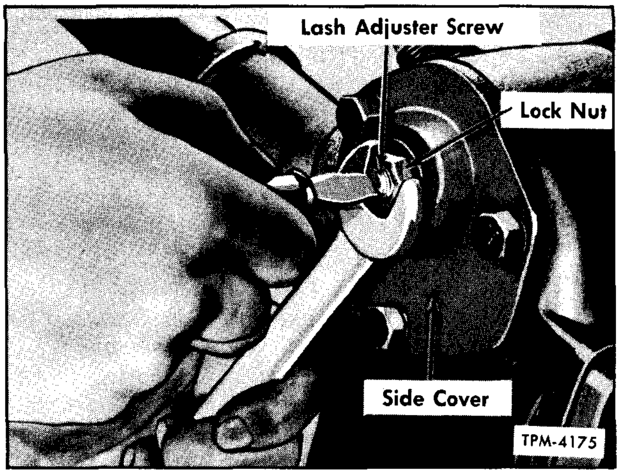


Figure 3—Sector Gear Lash Adjustment (Typical)

NOTE: Before making any steering gear adjustment, check lubricant in gear housing and fill to proper level, if necessary, as directed in LUBRICATION (SEC. 0) of this manual. Tighten all mounting bolts to torque recommended in "Specifications" at end of this section.

Procedures for checking and adjusting the steering gear must be performed in sequence given in the following paragraphs:

Always check worm bearing adjustment first, and adjust if necessary, before making Pitman shaft lash adjustment.

NOTE: Before making any adjustments on the steering gear, loosen back-up adjuster lock nut (if used); then loosen back-up adjuster.

CHECKING WORM BEARING ADJUSTMENT

1. Disconnect drag link, idler link, or connecting rod from Pitman arm. Note relative position of linkage and Pitman arm so parts may be reassembled in same relative position. Refer to "Steering Linkage" later in this section for correct procedures.

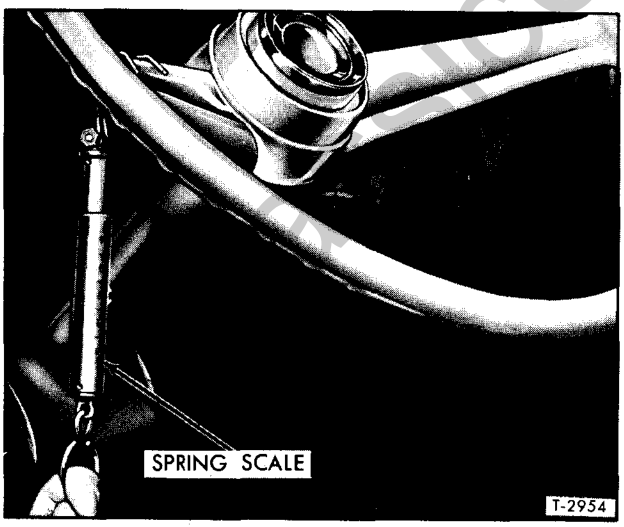


Figure 4—Checking Steering Wheel Rim Pull (Typical)

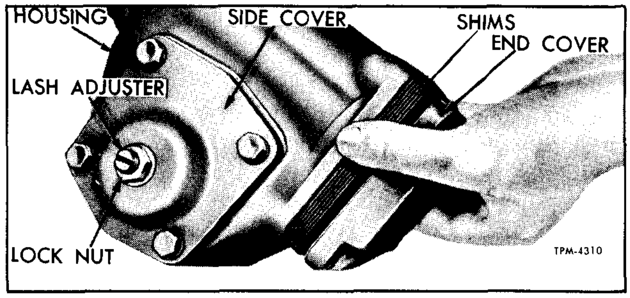


Figure 5—Installing End Cover Shims (568-D) (Typical)

2. Loosen lock nut and turn lash adjuster (fig. 3) a few turns counterclockwise to relieve load from worm bearings and to provide clearance between the sector gear and worm ball nut.

3. Turn steering wheel GENTLY in one direction until stopped by gear "stops" or by reaching end of travel, then back away one full turn.

IMPORTANT: Do not turn steering wheel hard against "stops" when linkage is disconnected from Pitman arm as damage to ball guides may result.

4. Attach spring scale (J-544-01) at rim of wheel as shown in figure 4. Pull on scale in a line at right angle to wheel spoke and measure the amount of pull required to keep the wheel moving. If worm bearings are properly adjusted, reading on spring scale should be between 1½ and 2 pounds.

If pull is not within 1½ to 2 pounds, worm bearings require adjustment. If "rough" or "lumpy" action is noted during check, worm bearings are

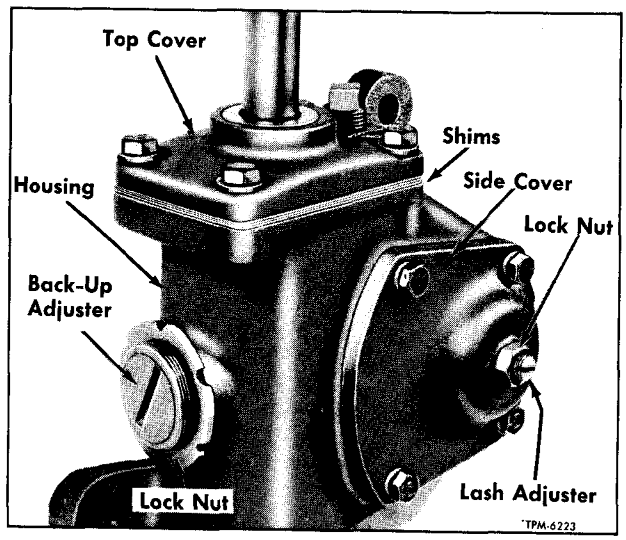


Figure 6—Steering Gear Adjustment Points (Type 568-D) (Typical)

probably damaged. Steering gear should them be removed, disassembled and bearings examined. If worm bearings do not require adjustment, adjust Pitman shaft lash as described later in this section. Adjust worm bearings as follows:

WORM BEARING ADJUSTMENT

Type 553-D and 555-D Steering Gear

1. Loosen adjuster lock nut at shaft end of steering gear and turn worm bearing adjuster screw clockwise until there is no perceptible end play in the worm.

2. Using spring scale (J-544-01), check steering wheel rim pull as outlined previously. Turn adjuster screw until a pull of 1½ to 2 pounds is obtained on spring scale at steering wheel.

3. Tighten adjuster lock nut to torque recommended in "Specifications."

Type 568-D Steering Gear

Proper adjustment of worm bearings is obtained by adding or removing shims between steering gear housing and top cover or end cover (fig. 2). Shims are available in thicknesses of 0.002", 0.005", 0.010", and 0.030".

1. Drain lubricant from gear housing, then remove top cover or end cover and shim pack. Discard one thin shim and reinstall balance of shims.

2. Check steering wheel rim pull as previously described. Reading on scale should be within 1½ to 2 pounds. Readjust worm bearing by adding or removing shims until correct adjustment is obtained (fig. 5 or 6).

3. Refill gear housing with lubricant specified in LUBRICATION (SEC. 0); then check wheel pull.

PITMAN SHAFT LASH ADJUSTMENT

1. Center steering gear by turning steering wheel from extreme right to extreme left positions, counting the exact number of turns. Turn wheel back exactly half-way, to center position. Mark wheel at top or bottom center with a piece of tape.

2. Loosen lash adjuster lock nut and turn adjuster screw (fig. 5 or 6) clockwise to remove all backlash between gear teeth. Tighten lock nut to 25 to 35 foot-pounds torque, then check steering wheel rim pull as outlined previously. Measure greatest pull as wheel is pulled through center position. Rim pull should be 2-¾ to 3¼ pounds.

3. If rim pull is not within specified limits, loosen lock nut and turn lash adjuster to obtain proper wheel rim pull. Always check wheel rim pull after lock nut has been tightened.

4. If steering gear is equipped with a back-up adjuster, turn adjuster in until it bottoms, then back off 1/8 to 1/4 turn and tighten lock nut.

5. After all adjustments have been completed, reconnect linkage to Pitman arm and adjust.

STEERING LINKAGE

NOTE: All drag link, connecting rod, tie rod, and idler link attaching bolts and clamp bolts and nuts, are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with parts of the same part numbers or with equivalent parts if replacement becomes necessary. Do not use replacement parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

Turning motion from the steering wheel is transmitted through the steering gear and linkage to steering arms at right and left front wheels. Steering linkage, although similar, is not the same for all series vehicles covered in this manual. Refer to applicable text and illustrations for each series vehicle.

Steering linkage between steering gear and front wheels affects steering action. If parts are out of adjustment, bent, damaged, or twisted, poor steering will result. Steering linkage should be properly adjusted at all times.

NOTE: Whenever any steering linkage components have been repaired or replaced, check steering geometry and front end alignment as described in FRONT SUSPENSION (SEC. 3) of this manual.

DRAG LINK

Several type drag link assemblies are used on vehicles covered by this manual.

The drag link assembly shown in View A, figure 7, is non-adjustable or repairable. If ball stud looseness, wear, or damage is indicated, replace the complete drag link assembly.

The drag link assembly shown in View B, figure 7, has a replaceable ball stud end assembly. The threaded end plug can be removed to replace components within the socket end of the drag link.

REMOVAL

View A, Figure 7

1. Remove cotter pin and nut from each end of the drag link. Discard cotter pins.

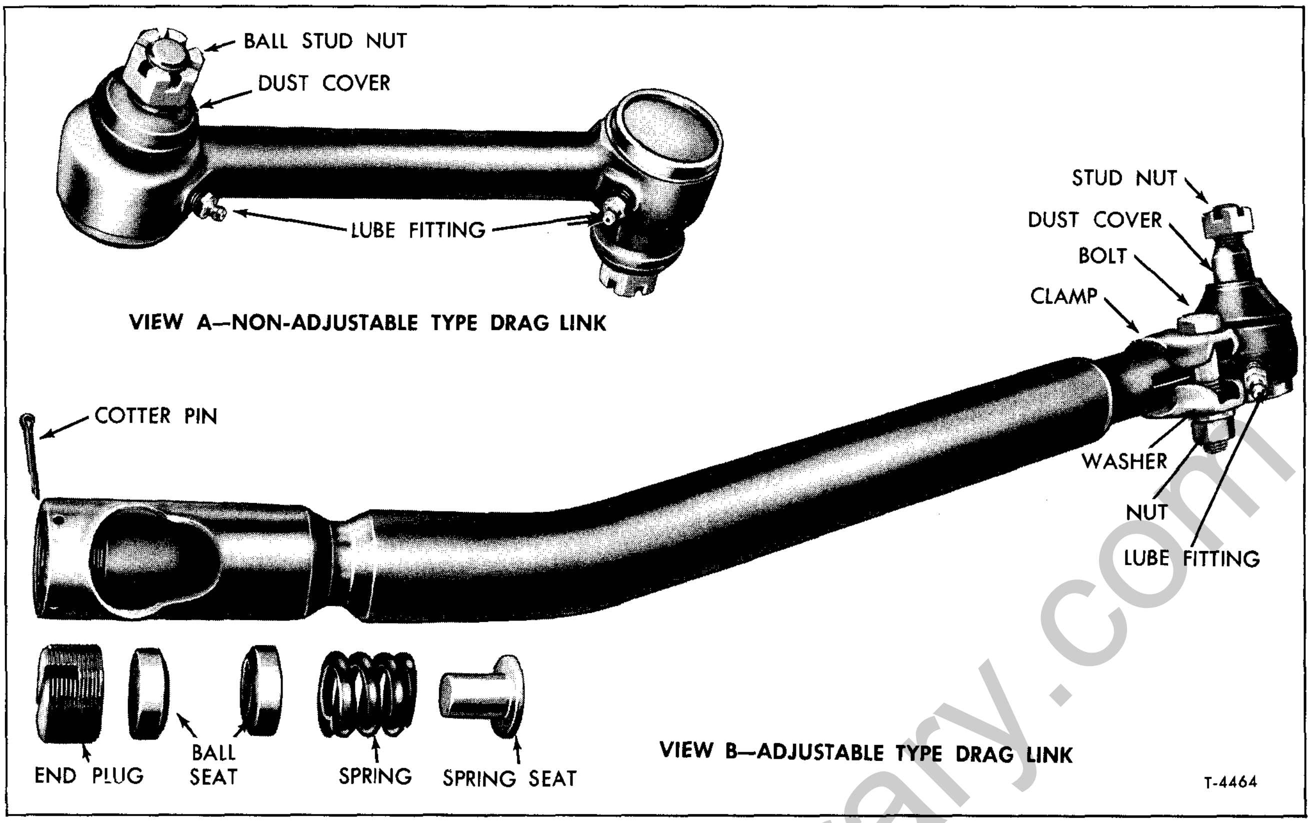


Figure 7—Steering Drag Link Assemblies (Typical)

2. Use a soft hammer to tap each ball stud until drag link is loose. Steering arm should be supported when hammering on stud. Remove the drag link assembly.

View B, Figure 7

1. Remove cotter pin and nut from ball stud end of drag link and discard cotter pin.
2. Using a soft hammer, tap ball stud to loosen drag link.
3. At socket end of drag link, remove cotter pin and discard.
4. Use a drag link bit to loosen end plug until spring tension is relieved on the ball, then remove the drag link.

DISASSEMBLY

NOTE: The drag link shown in View A, figure 7, cannot be disassembled. If ball studs are worn or damaged, replace the complete assembly.

The drag link shown in View B, figure 7, can be disassembled as follows:

1. The end assembly which is clamped to the drag link cannot be repaired. If the ball stud end assembly is worn or damaged, loosen the clamp bolt, then remove the end assembly.
2. At socket end of drag link, remove end plug, ball seats, spring, safety plug, and safety plug seat.

INSPECTION

1. Use a suitable solvent to thoroughly clean all drag link parts. Wipe or blow parts dry.
2. Inspect parts for wear or damage and discard all parts that are not in first class condition.
3. Check spring for distortion or collapsed coils.

ASSEMBLY (VIEW B, Fig. 7)

1. At ball stud end of drag link, thread a new end assembly into drag link.
2. At socket end of drag link, install safety plug seat, safety plug, spring, ball seats, and end plug loosely.

INSTALLATION

View A, Figure 7

1. Position drag link to Pitman arm and steering arm. Install a ball stud nut at each end and tighten firmly.

NOTE: This initial tightening will fit the tapered studs snugly and prevent movement when nuts are torqued.

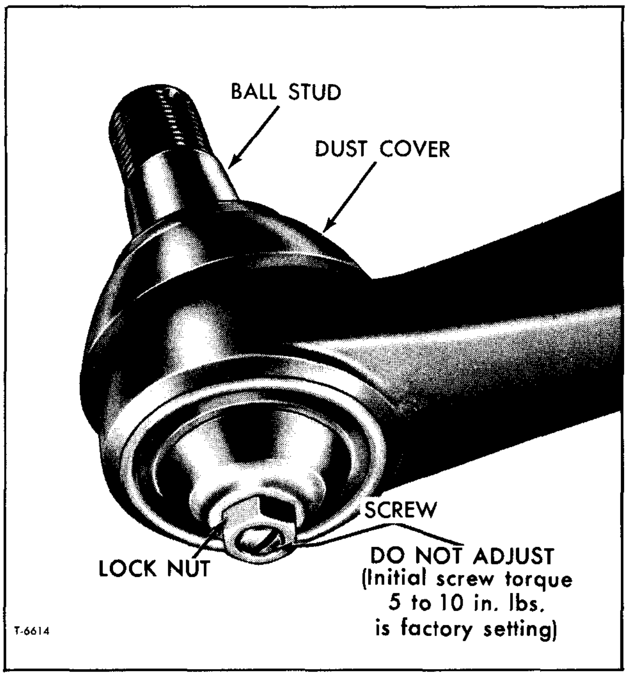


Figure 8—Steering Connecting Rod (Typical)

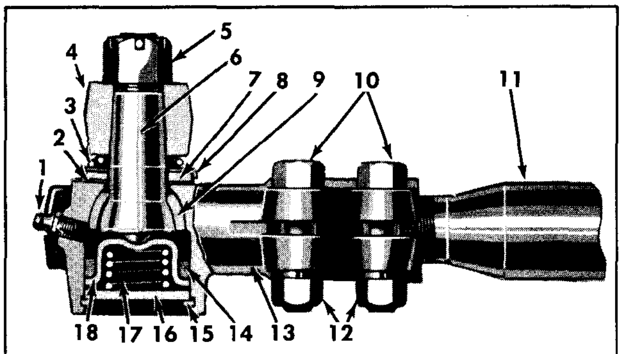


Figure 9—Tie Rod Construction (F120 and F160 Front Axle) (Typical)

2. Use a torque wrench to tighten stud nuts to torque listed in "Specifications" at end of this section, then advance nut to the next aligning hole and install a new cotter pin to secure stud nut.

View B, Figure 7

1. Position drag link over ball stud at idler lever. Use a drag link to tighten end plug snugly to remove all end play from ball. Back off end plug ¼ to ½ turn and insert a new cotter pin to lock the adjustment.

IMPORTANT: Ball joints must be tight enough to prevent end play, yet loose enough to allow free movement.

2. With ball stud disconnected from steering arm, locate center of steering gear movement. Turn steering wheel gently from extreme right to extreme left, counting the exact number of turns. Turn steering wheel back exactly halfway. Front wheels should be in straight-ahead position.
3. With front wheels in straight-ahead position, adjust drag link end assembly until stud fits into boss in steering arm without changing position of front wheels or steering gear. Tighten ball stud nut firmly.
4. Use a torque wrench to tighten stud nut to torque listed in "Specifications" at end of this section, then advance nut to the next aligning hole and install a new cotter pin to secure the stud nut.
5. Check clearance around the ball stud neck with wheels in the straight-ahead position. Clearance around the ball stud should be uniform. If necessary to obtain a uniform clearance, turn ball stud end of drag link slightly; then use a torque wrench to tighten clamp bolt to torque listed in "Specifications" at end of this section.

CAUTION: Drag link must not bind on ball studs as wheels are turned to extreme right and left positions.

DRAG LINK END ADJUSTMENT
(VIEW B, Fig. 7)

The socket end of the drag link shown in View B, figure 7, can be manually adjusted. This adjustment is required whenever drag link has been overhauled or whenever the idler lever ball is found to have end play in drag link socket. Adjust drag link as follows:

1. Remove cotter pin from end of socket, then use a drag link bit in screw plug slot to tighten plug firmly to remove all end movement from ball.
2. Back off end plug ¼ to ½ turn and install a new cotter pin to lock the adjustment. Ball joints must be tight enough to prevent end play, yet loose enough to allow free movement. Thoroughly lubricate end sockets.

STEERING CONNECTING ROD

A non-adjustable connecting rod is used on some models to connect the Pitman arm to the steering arm. No periodic maintenance is required other than keeping stud nuts properly torqued. If connecting rod becomes worn or damaged, replace the complete assembly in same manner as non-adjustable drag link explained previously.

Series 70 steel tilt cab models equipped with the F-090 front axle of the type shown in figure 8. If ball stud looseness is found on this rod, replace the rod. This adjustment feature is not to be used for field service adjustments, it was intended for manufacturing adjustment only.

TIE ROD

Vehicles covered in this manual have a three-piece tie rod connecting left and right steering arms. The tie rod consists of a tube and two socket end assemblies. Tube is threaded into socket ends and locked with clamp bolts. Right and left threads are provided to facilitate toe-in adjustments and steering gear centering.

On vehicles equipped with F-070 or F-090 front axles, tie rods are self-adjusting and require no attention in service other than periodic lubrication and inspection to see that ball studs are tight. Socket ends should be replaced when excessive up and down motion or any lost motion or end play at ball end of stud exists.

On vehicles equipped with F-120 or F-160 front axle, tie rod ends (fig. 9) are constructed to automatically compensate for wear at bearing surfaces. Tie rod end parts are replaceable. Snap ring and plug can be removed from socket end to permit removal of end stud, bearing, and seat. Tie rod socket ends are self-adjusting and require no attention in service other than periodic lubrication and occasional inspection to check end studs in steering arms. If stud is allowed to work loose, excessive play will enlarge holes in steering arms.

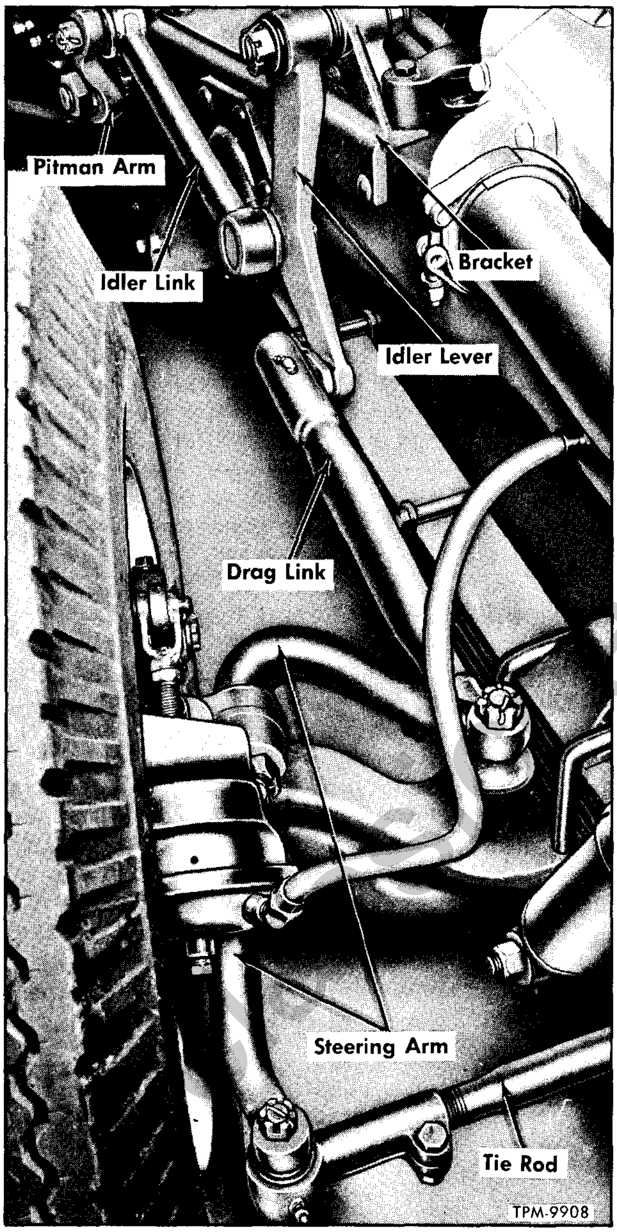


Figure 10—Steering Linkage (TM80) (Typical)

MAINTENANCE

1. Clamp bolt nuts should be periodically checked for tightness.

2. Inspect tie rod for bent condition. If tie rod is bent more than 5 degrees, replace assembly. If tie rod is bent less than 5 degrees, tie rod may be straightened by cold straightening method.

3. Lubricate tie rod ends as directed in LUBRICATION (SEC. 0) of this manual.

TIE ROD REPLACEMENT

Removal

1. Remove cotter pins and stud nuts attaching tie rod to right or left steering arm.

2. Remove ball stud from steering arm by tapping on steering arm with a hammer while using a heavy hammer as a backing at the steering arm. Push upward on tie rod to remove from steering arm.

NOTE: If tie rod end assemblies are damaged in any way, they must be replaced.

Installation

1. If socket end assemblies were removed from tie rod, install socket ends on tie rod. Be sure both ends are threaded an equal distance into the tie rod.

2. Make sure threads on stud and in stud nut are clean and not damaged.

3. Position ball studs on socket ends of tie rod in holes in steering arms. Place a hardened flat washer (if used) over each ball stud. Install a ball stud nut on each stud and tighten firmly to seat the tapered stud.

4. Use a torque wrench to tighten stud nuts to torque listed in "Specifications" at end of this section, then advance stud nut to the next aligning slot and install a new cotter pin to secure the nut. Lubricate the end sockets as described in LUBRICATION (SEC. 0) of this manual.

5. Adjust toe-in described in "FRONT END ALIGNMENT" (SEC. 3A) of this manual.

6. Check to be sure tie rod ends are in proper alignment with ball studs, then tighten tie rod end clamp bolts to torque listed in "Specifications."

IMPORTANT: If tie rod is not properly aligned with the stud, binding will result.

TOE-IN ADJUSTMENT

1. Loosen clamp bolts at each tie rod end.

2. Using a pipe wrench, turn tie rod center tube as required to set toe-in to dimension given in "FRONT END ALIGNMENT" (SEC. 3A) of this manual.

TIE ROD REMOVAL AND DISASSEMBLY

NOTE: Key numbers in text refer to figure 9.

1. Remove cotter pins and nuts (5) from tie rod end studs, support steering arm to prevent bending; then drive tie rod end tapered stud (6) out of steering arms. Remove dust cork spring (3) dust cork shield (8), dust cork (7), and dust cork washer (2).

2. Loosen clamp bolts, then remove each tie rod socket end assembly from tie rod tube (11).

3. Pry out retaining lock ring (15), then remove retaining washer (16), seat spring (17), spring seat (18), grease seal (14), stud (6), and stud bearing (9).

INSPECTION

Clean all tie rod parts, then inspect for wear and other damage. Discard worn parts and replace springs if found to be weak.

ASSEMBLY AND INSTALLATION
(Refer to Figure 9)

1. Lubricate tie rod end parts with lubricant specified in LUBRICATION (SEC. 0) of this manual before assembling.

2. Position stud bearing (9) in end socket.

3. Install stud (6), place grease seal (14) on spring seat (18), then install spring seat.

4. Position seat spring (17) and retaining washer (16), then install lock ring (15).

5. Install tie rod socket ends on tube, threading each end the same number of turns on tube, then install clamp bolts but do not tighten clamp bolt nuts at this time.

6. Install dust cork washer (2), dust cork (7), dust cork shield (8), and dust cork spring (3) on tapered stud in order listed.

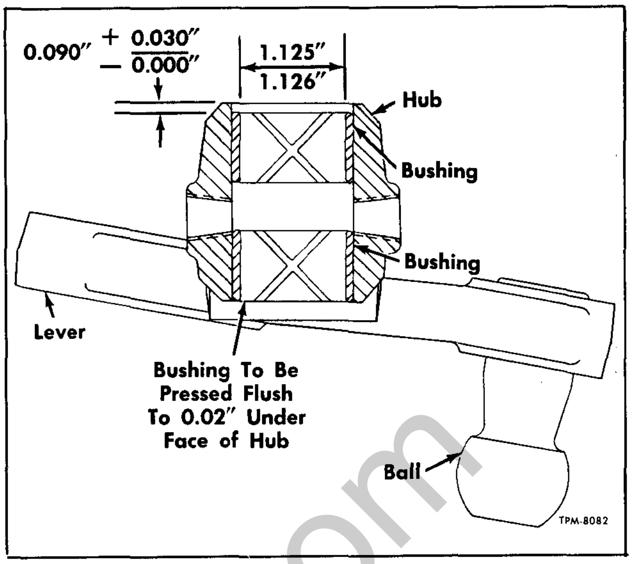


Figure 11—Idler Lever Bushing Replacement (TM80, Tilt Models) (Typical)

7. Make certain the stud holes in steering arms, and stud nuts are clean and dry, then position tie rod assembly on steering arms. Install tie rod stud nuts (5). Tighten stud nuts to torque given in "Specifications," then install cotter pin.

8. Adjust toe-in as described in "FRONT END ALIGNMENT" (SEC. 3A) of this manual.

IDLER LINK (TM80 TILT CAB MODELS)

An idler link is used to connect the Pitman arm to the idler lever on Series TM80 tilt cab models.

REMOVAL (Fig. 10)

1. Remove cotter pin and nut attaching the idler link to Pitman arm.

2. Remove cotter pin and nut attaching idler link to idler lever.

3. Using a hammer, tap idler link loose from Pitman arm and idler lever.

NOTE: The idler link, if worn or damaged, must be replaced as a complete assembly. Parts are not furnished separately.

INSTALLATION (Fig. 10)

1. Position idler link studs in holes in Pitman arm and idler lever.

2. Install stud nuts and tighten to torque listed in "Specifications" at end of this section, then advance to next hole and install new cotter pins.

IDLER LEVER BUSHING REPLACEMENT (TM80—TILT CAB MODELS)

REMOVAL AND DISASSEMBLY (Fig. 11)

1. Remove idler link from idler lever as previously described.
2. Remove cotter pin and turn end plug of drag link enough that drag link can be removed from idler lever ball stud.
3. Remove cotter pin, nut, and washer which attach idler lever to support bracket.
4. Remove idler lever and inner and outer dust seals from support bracket.
5. Using a press and suitable sleeve, press inner and outer bushings from idler lever.
6. Clean idler lever and check for wear or damage. If worn, or damaged, discard lever and use new part at assembly.

ASSEMBLY AND INSTALLATION (Fig. 11)

1. Using a press and suitable sleeve, press new inner and outer bushings into bore of idler lever. Press bushings in to dimensions shown in figure 11.
2. Position idler lever and inner and outer dust seals on support bracket shaft, then attach with nut and washer. Tighten nut securely and install new cotter pin.
3. Position drag link on idler lever ball stud, then using a suitable tool, tighten end plug firmly to remove all end play.
4. Back off end plug ¼ to ½ turn and install new cotter pin to lock the adjustment. Ball joint must be tight enough to prevent end play, yet loose enough to allow free movement.
5. Install idler link on idler lever, attaching with stud nut and new cotter pin.

STEERING WHEEL AND STEERING COLUMN

NOTE: All steering wheel, steering column, and steering shaft coupling attaching bolts and nuts, are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with parts of the same part numbers or with equivalent parts if replacement becomes necessary. Do not use replacement parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

STEERING WHEEL REPLACEMENT (ALL SERIES EXCEPT ALUM. TILT CAB)

REMOVAL

1. Disconnect directional signal switch harness from chassis wiring harness connector.
2. Set front wheels in straight-ahead position, then pry horn button cap and retainer from steering wheel.
3. Remove steering wheel nut and washer.
4. Using puller (J-2927-01), remove steering wheel (fig. 12). It may be necessary to tap on bolt head of tool with a hammer as it is turned down to loosen a tight steering wheel.

INSTALLATION

NOTE: Front wheels must be in straight-ahead position and directional signal control assembly must be in neutral position when installing steering wheel.

1. On vehicles equipped with a two-spoke steering wheel, position wheel on steering shaft with spokes of wheel in a horizontal position. On vehicles equipped with a three-spoke wheel, position wheel on shaft with lower spoke of steering wheel in vertical position.
2. Tap steering wheel gently into place.
3. Install washer and steering wheel locking nut on steering shaft. Tighten nut to torque listed in "Specifications" at end of this section.
4. Install retainer and horn button cap and connect directional signal wiring harness to chassis wiring harness connector.

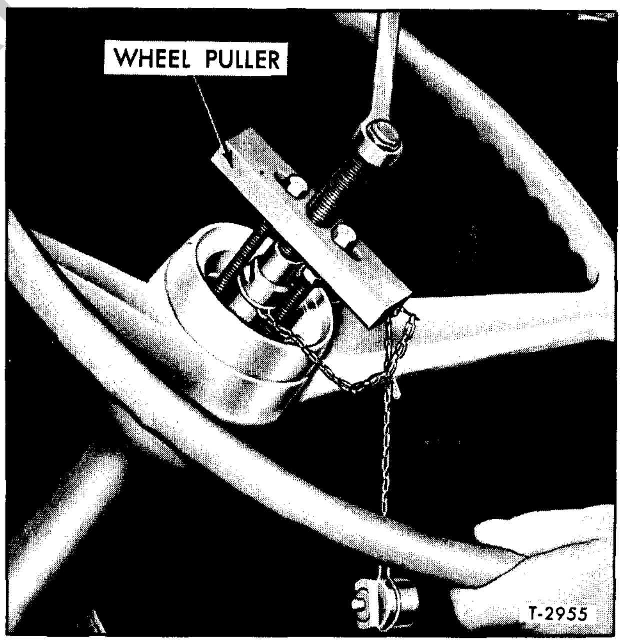


Figure 12—Steering Wheel Removal (Typical)

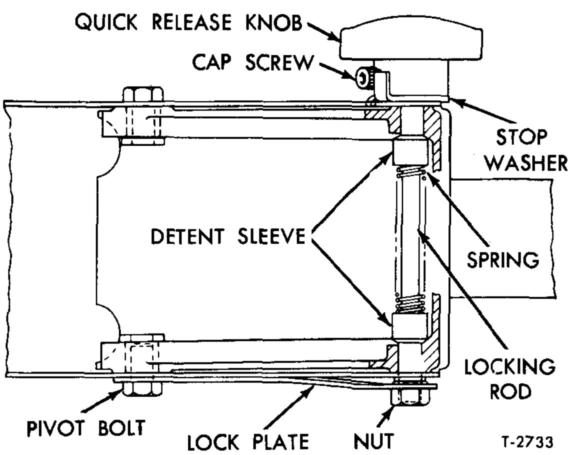


Figure 13—Tilt Column Quick Release Mechanism

STEERING WHEEL REPLACEMENT (ALUM. TILT CAB)

REMOVAL

1. Pull out knob of master circuit breaker to disconnect horn control circuit.
2. Position front wheels in straight-ahead position.
3. Pry off horn button cap and mark steering wheel-to-steering shaft relationship.
4. Remove steering wheel nut and washer.
5. Remove three horn button retainer cup attaching screws, screw insulator, and Belleville spring.
6. Remove steering wheel using puller (J-2927-01) as illustrated in figure 12. It may be necessary to lightly tap on bolt head of tool with a hammer as the bolt is turned down.

INSTALLATION

1. Position steering wheel on shaft, making sure alignment marks are phased. The mark on hub of wheel must align with mark on shaft.

NOTE: It may be necessary to exert upward pressure on steering shaft to provide sufficient shaft protrusion through steering wheel to start nut and washer.

2. Install steering wheel nut and washer, then tighten nut to 45 to 50 foot-pounds torque.
3. Belleville spring should be positioned with the concave side down and horn button retainer should be installed with locating notch at the top or 12 o'clock position. Place Belleville spring inside steering wheel, followed by horn button retainer cup, insulator assembly and three attaching screws. Tighten screws to 20 to 30 inch-pounds torque.
4. Install horn button cap.
5. Push the master circuit breaker knob inward. Check operation of horn.

FOUR POSITION TILT STEERING COLUMN (EXCEPT ALUM. TILT CAB)

The steering wheel used on conventional cab models may be adjusted to any one of four positions. To reposition the wheel, remove through-bolt and nut from adjustment slot on steering column, and move steering wheel to desired position. Install through-bolt through adjustment slot and tighten securely.

TILT COLUMN QUICK RELEASE

Some vehicles are equipped with a quick release mechanism to facilitate repositioning the steering column. To reposition the steering wheel, turn the quick release knob counterclockwise and move the wheel to desired position, then turn the knob clockwise until the steering column is secure.

The quick release mechanism may be replaced as follows. (Refer to fig. 13).

1. Depress lock plate and remove nut from locking rod.
2. Pull quick release knob and locking rod from housing.

NOTE: Two detent sleeves and a spring will remain in housing.

3. Position quick release knob and locking rod through housing, making sure rod passes through detent sleeves and spring.
4. Depress lock plate and install nut on locking rod. The nut should be loose enough to allow column to tilt, but tight enough to hold column secure after turning release knob approximately 90 degrees.

NOTE: To adjust nut, depress locking plate allowing nut to turn. After adjusting nut, allow plate to return to its normal position.

IMPORTANT: DO NOT ATTEMPT TO REPOSITION THE STEERING WHEEL WHILE THE VEHICLE IS MOVING.

FOUR POSITION TILT STEERING COLUMN (ALUM. TILT CAB)

TILT-COLUMN QUICK RELEASE

The quick release, adjustable steering column, on Alum. Tilt Cab Models covered by this manual,

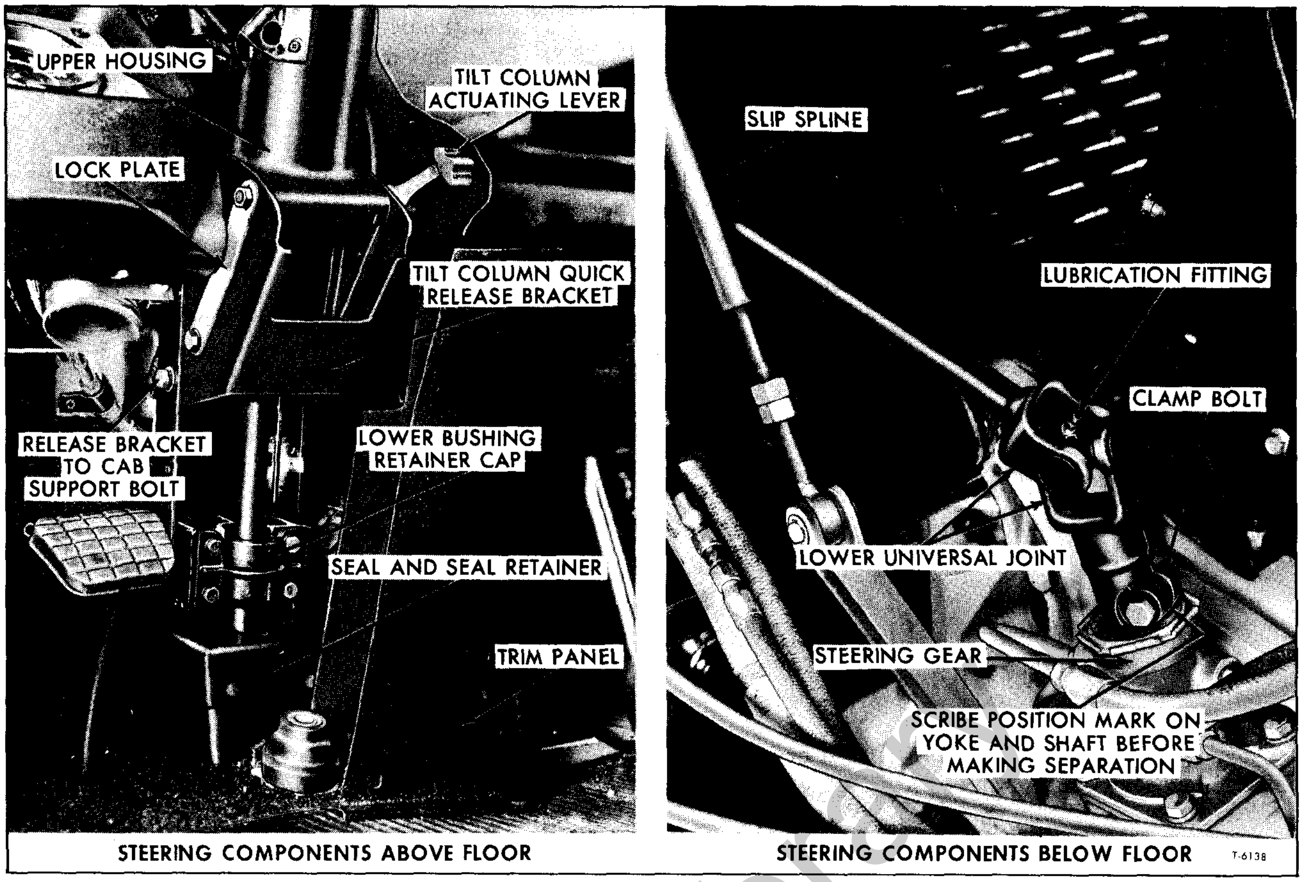


Figure 14—Steering Column and Shaft Components (Alum. Tilt Cab)

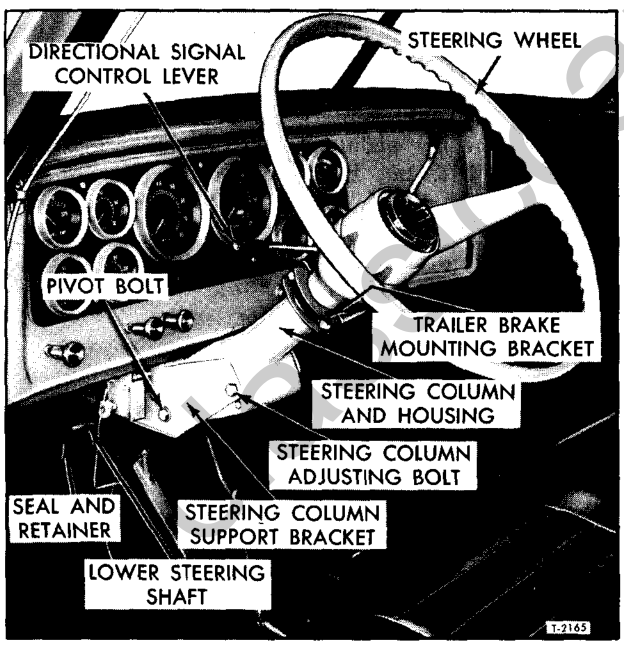


Figure 15—Steering Column and Shaft Components (Conventional Cab Models) (Typical)

has a lever actuated adjusting mechanism (refer to figure 14). To adjust the steering column, push the actuating lever downward (toward the cab floor), move the column to the desired position and while holding the column, push the actuating lever upward (toward the instrument panel) to lock the column in position.

STEERING COLUMN AND SHAFT (CONVENTIONAL CAB MODELS)

REMOVAL (Fig. 15)

1. Disconnect directional signal and hazard warning lighting connector from under dash (refer to fig. 16).

2. Remove steering wheel as described under "Steering Wheel Replacement" previously on page 11.

3. Mark clamp yoke and steering gear worm shaft to ensure installation in the same relative position (fig. 17).

4. Remove bolt attaching clamp yoke on steering shaft to steering gear worm shaft.

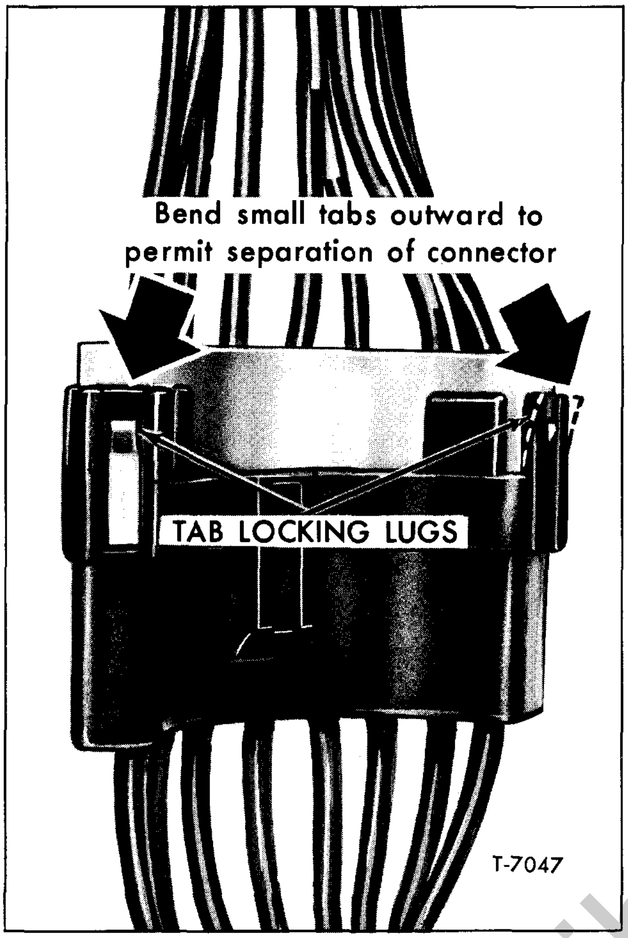


Figure 16—Directional and Hazard Warning Switch Connector

5. If used, remove cap screws and lock washers which attach the trailer brake hand control valve to the steering column, then remove the attaching clamp.

6. Remove screws which attach steering column seal retainer and seal to cab floor.

7. Remove the bolts which attach the steering column to the supports and braces, then pull the housing off the steering shaft and remove from the vehicle.

8. Lift clamp yoke off steering gear worm shaft, then twist and turn the shaft assembly as required to remove from vehicle.

DISASSEMBLY (Fig. 18)

1. Remove screw attaching directional signal control lever to control assembly and remove the lever.

2. Remove two screws which attach hazard warning switch to housing and three screws which

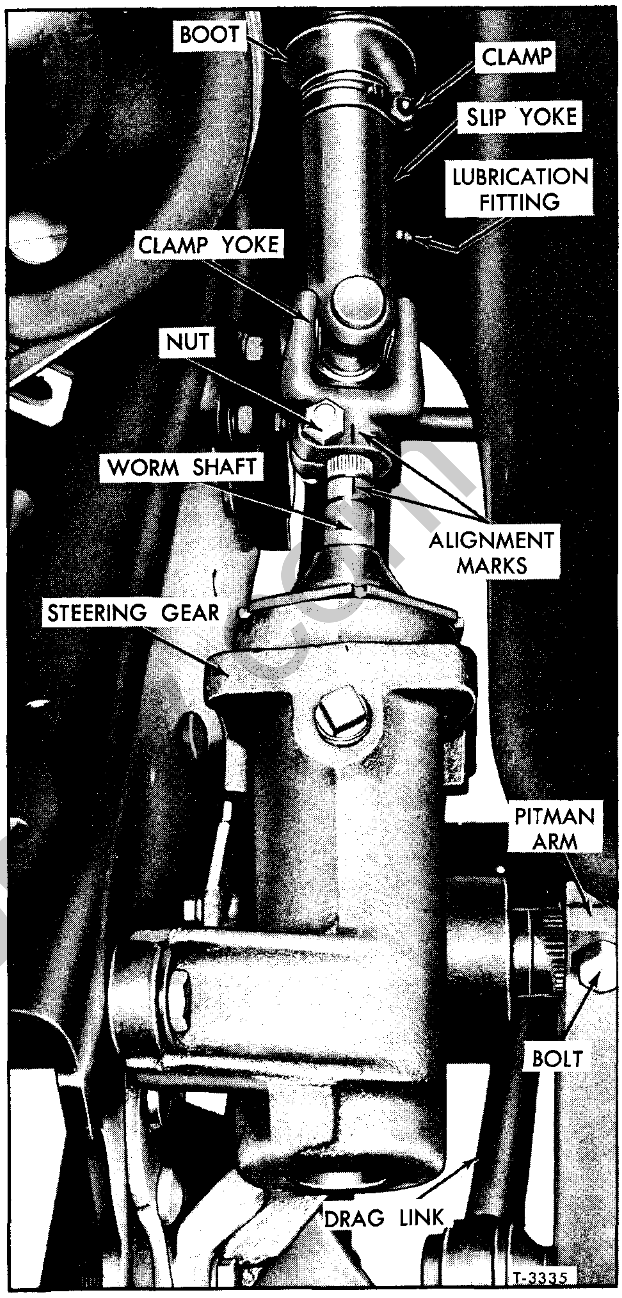


Figure 17—Steering Gear and Intermediate Shaft Installed (Conv. Cab Models) (Typical)

attach directional signal control assembly to control housing (fig. 19)

3. Remove steering column from upper shaft assembly. If worn or damaged, pry bearing assembly from lower end of steering column (refer to fig. 20).

4. Remove the bearing outer seal, spring seat, and spring from the one-piece steering shaft;

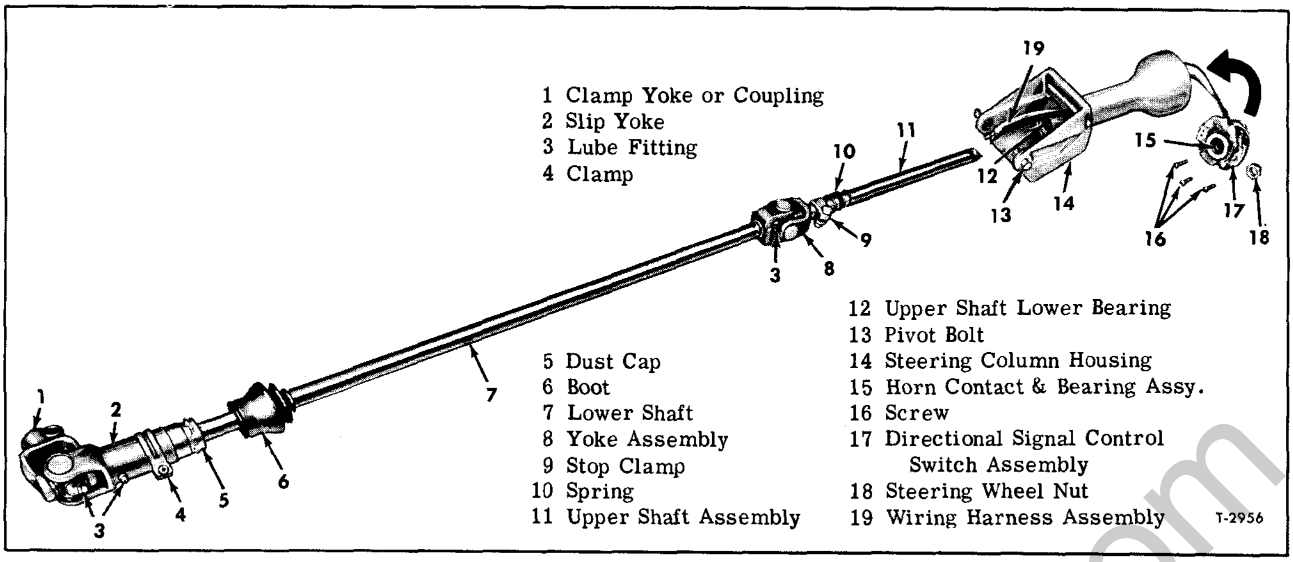


Figure 18—Steering Column and Shaft Removed (Conventional Cab Models) (Typical)

or remove the spring seat and spring from the lower end of the upper shaft. Remove stop bolt, nut, washer, and "stop" clamp from the steering shaft.

5. Remove two snap rings, two tube yoke bushings, and two cork washers which attach steering upper shaft yoke to intermediate shaft yoke. Discard cork washers.

INSPECTION

1. Inspect steering shaft bearing for damage. The bearing may be replaced if worn or damaged by prying out of housing. Press new bearing into housing.

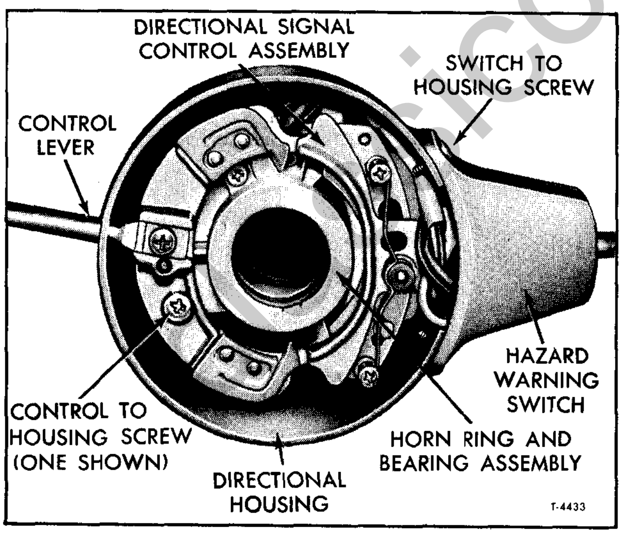


Figure 19—Directional Signal Control Assembly (Typical)

2. Inspect wiring, connections, and control assembly. Replace if damaged.

3. Check directional signal lever for smoothness of operation and freedom from bind. Replace parts which do not operate smoothly.

4. Clean all the parts and inspect for damage or wear and replace all the parts which are not in good condition.

ASSEMBLY

1. If previously removed, press lower bearing into mast jacket.

2. Position hazard warning switch on control housing and attach with two screws; then position directional signal control assembly in housing and attach with three screws. Route hazard warning switch wires around outside of control assembly then tighten control to housing screws to 30 to 40 inch-pounds torque. Install directional signal control lever.

3. Place "stop" clamp on lower end of upper steering shaft and install bolt, nut, and lock washer loosely. Install spring and spring seat on lower end of upper shaft and install bolt, nut, and lock washer loosely.

4. Position the center cross on the column upper shaft yoke in the lower shaft yoke. Install two new cork washers, two yoke bushings, and two snap rings.

5. Move seal, seat, spring, washer, and "stop" clamp into position. Tighten clamp bolt to torque recommended in "Specifications" at end of this section.

NOTE: Adjust the "stop" clamp to allow 0.005" (min.) to 0.030" (max.) axial movement of shaft assembly.

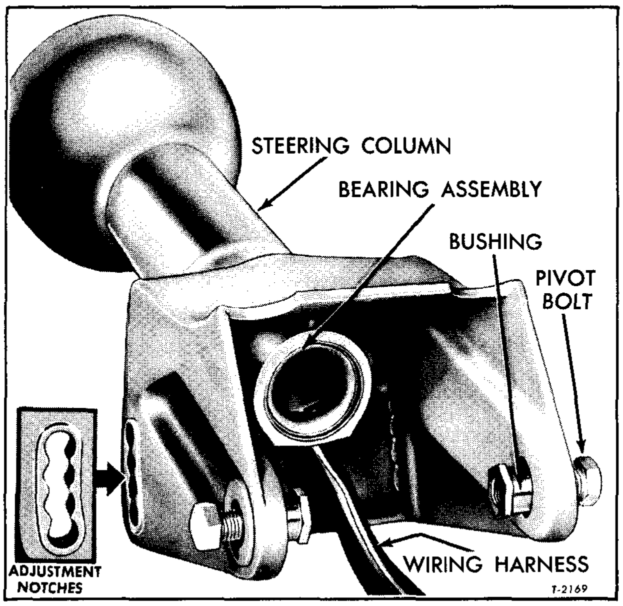


Figure 20—Steering Column Upper Shaft Lower Bearing (Conventional Cab Models) (Typical)

INSTALLATION

1. Position steering column, upper and intermediate steering shaft, steering column seal, and seal retainer in vehicle.

2. Position clamp yoke or slip yoke on steering shaft on steering gear worm shaft with match marks aligned.

3. Position steering column over upper end of steering shaft assembly, then install the dash support brace, if removed. Raise steering column into position and install bolts to attach the column to supports and braces.

IMPORTANT: To prevent axial bind, the cab mounts and steering shaft to worm shaft clamp bolts must be tightened prior to tightening steering column to dash and instrument panel bolts.

4. Install screws which attach steering shaft seal and retainer to cab floor.

5. If removed, position trailer brake hand control valve on steering column and attach with clamp.

6. Check alignment mark on steering shaft coupling or clamp yoke and steering gear worm shaft for proper alignment. Tighten clamp bolt to torque listed in "Specifications" later in this section.

7. Tighten steering column to dash and instrument panel supports to 15 to 20 foot-pounds torque.

8. Install steering wheel as described under "Steering Wheel Replacement" previously.

NOTE: If steering wheel "clunking" is audible, refer to "Steering Wheel Clunking Noise" later.

9. Connect directional signal and hazard warning lighting wiring connector to multiple connector under dash.

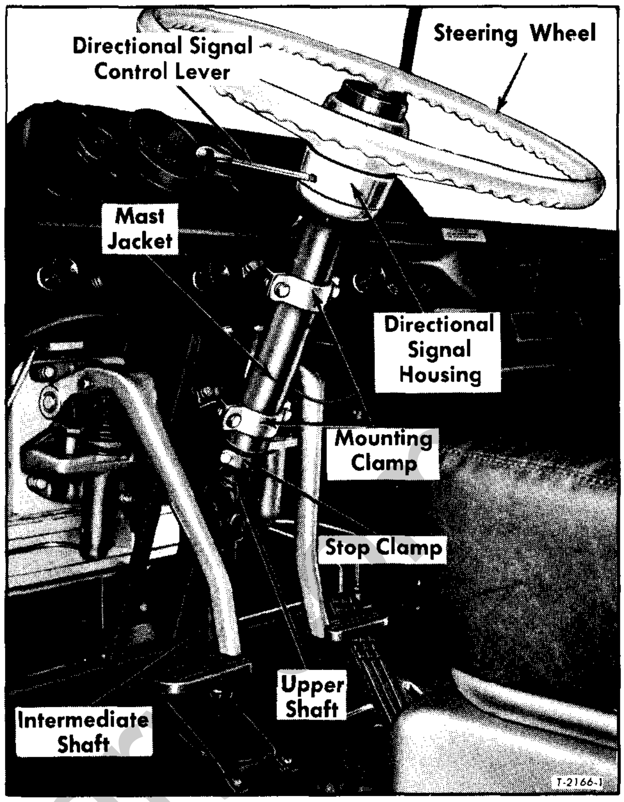


Figure 21—Steering Column and Shaft (Steel Tilt Cab Models) (Typical)

STEERING COLUMN AND SHAFT ASSEMBLY (STEEL TILT CAB MODELS)

REMOVAL (Fig. 21)

1. Disconnect directional signal wiring from multiple connector under dash.

2. Remove steering wheel as described earlier in this section.

3. Scribe an alignment mark on intermediate shaft clamp yoke and steering gear worm shaft to ensure installation in same relative position. Remove bolt and nut attaching intermediate shaft clamp yoke to steering gear worm shaft.

4. If vehicle is equipped with a trailer brake hand control valve, remove clamp attaching control valve to steering column, then move valve clear of column.

5. Remove steering column retainer and seal from cab floor.

6. Remove bolts attaching steering column to supports and braces. Twist and turn steering column and shaft assembly as required to remove from vehicle.

STEERING COLUMN AND UPPER SHAFT DISASSEMBLY

1. Remove directional signal control lever;

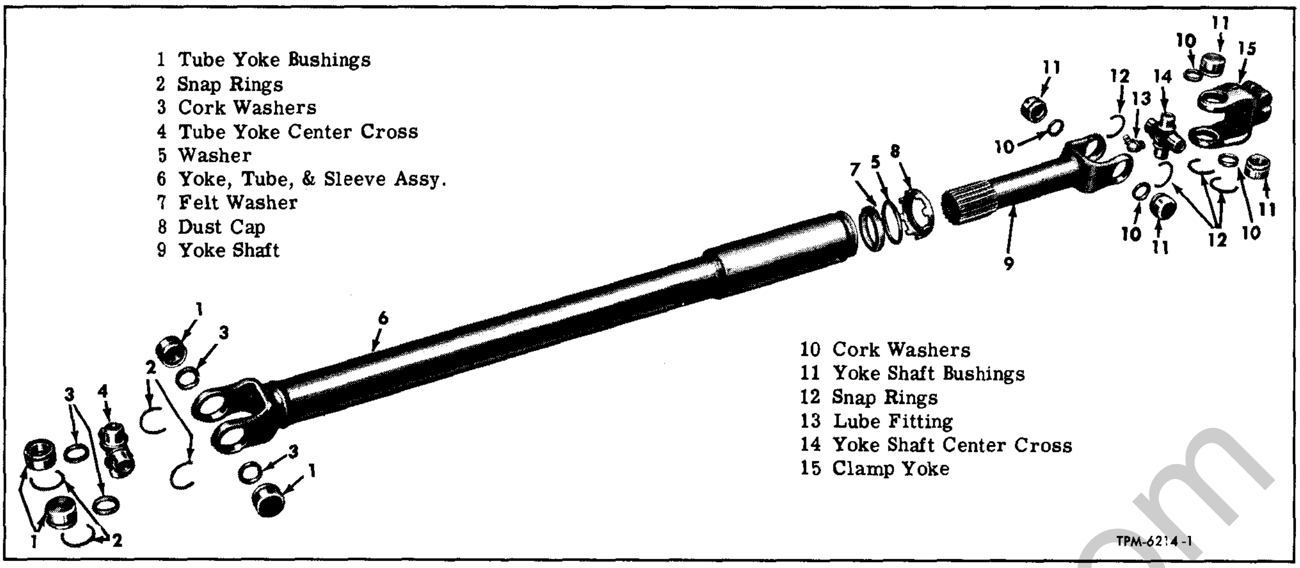


Figure 22—Intermediate Shaft Components (Typical)

then remove screws which attach directional signal control assembly to mast jacket.

2. Remove mast jacket from steering upper shaft assembly. Pry lower bearing assembly from mast jacket if worn or damaged.

3. Remove washer, spring, spring seat, and seal from lower end of upper shaft.

4. Remove "stop" clamp from lower end of upper shaft.

5. Remove two snap rings, two tube yoke bushings and two cork washers which attach steering column upper shaft yoke to intermediate shaft tube yoke. Discard cork washers.

INTERMEDIATE SHAFT DISASSEMBLY

NOTE: Key numbers in following text refer to figure 22.

1. Straighten tangs on yoke dust cap (8); then slide clamp yoke (15) and yoke shaft (9) out of yoke tube and sleeve assembly (6).

2. Remove felt washer (7), dust cap (8), and metal washer. Discard felt washer.

3. Remove two clamp yoke to yoke shaft snap rings (12); then tap yoke shaft (9) with a plastic hammer until two bushings (11) and two cork washers (10) fall off the center cross (14). Discard cork washers.

4. Remove two more clamp yoke to yoke shaft snap rings (12); then using a plastic hammer, tap yoke shaft until two bushings (11) and two cork washers (10) fall off the center cross (14). Discard cork washers.

5. Remove lubrication fitting (13) from center cross (14).

6. Remove two tube yoke snap rings (2); then tap yoke tube (6) with a plastic hammer until two bushings (1) and two cork washers (3) fall off the center cross (4).

NOTE: Two additional snap rings (2), bushings (1), and cork washers (3) were removed from center cross (4) when the intermediate shaft was removed from the vehicle.

7. Remove center cross (4) from yoke tube (6). Remove lubrication fitting (13).

INSPECTION

1. Inspect upper bearing for damage.

2. Inspect directional signal and horn wiring, connections, and control assembly. Replace if damaged.

3. Check operation of directional signal lever.

4. Clean all intermediate shaft parts thoroughly in cleaning solvent. Wipe or blow parts dry.

5. Check splines of yoke shaft and tube for nicks, scores, cracks, or other damage. Inspect tube and shaft for distortion.

6. Inspect tube yoke center cross and clamp yoke to yoke shaft center cross for nicks, scores, burrs, or other damage. Check for crossed or stripped threads.

7. Examine tube yoke bushings and clamp yoke to yoke shaft bushings for nicks, scores, wear or any other damage.

8. Inspect lubrication fittings for crossed or stripped threads. Check for plugged tube passage.

INTERMEDIATE SHAFT ASSEMBLY

NOTE: Key numbers in text refer to figure 22.

1. Install lubrication fitting (13) in center cross (4); then position center cross in yoke tube (6).

2. Position bushing (1) and new cork washer (3) on center cross (4). Install snap ring (2).

3. Place a second bushing (1) and new cork washer on center cross (4) and retain with snap ring (2).

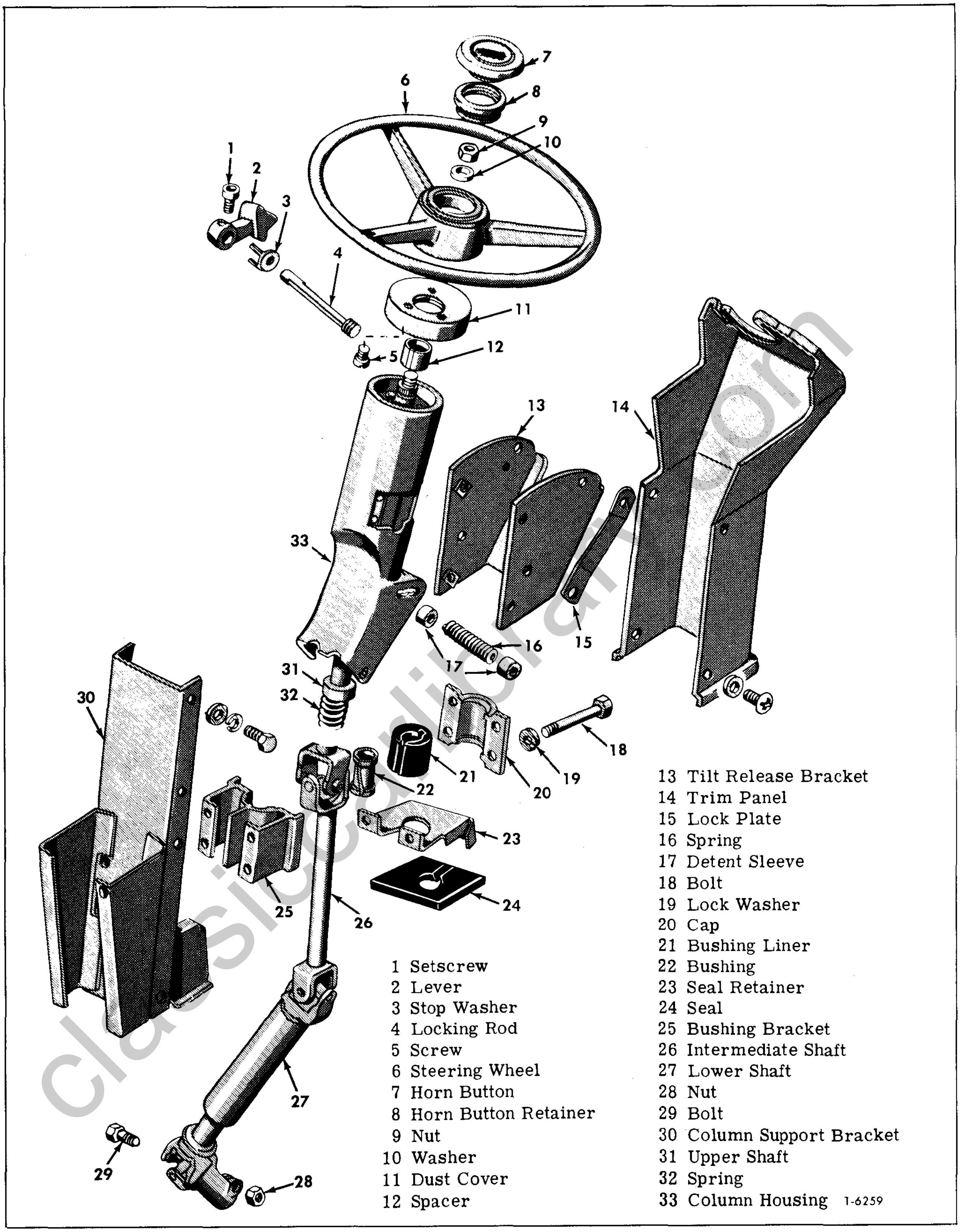


Figure 23—Steering Column and Shaft Components (Alum. Tilt Cab)

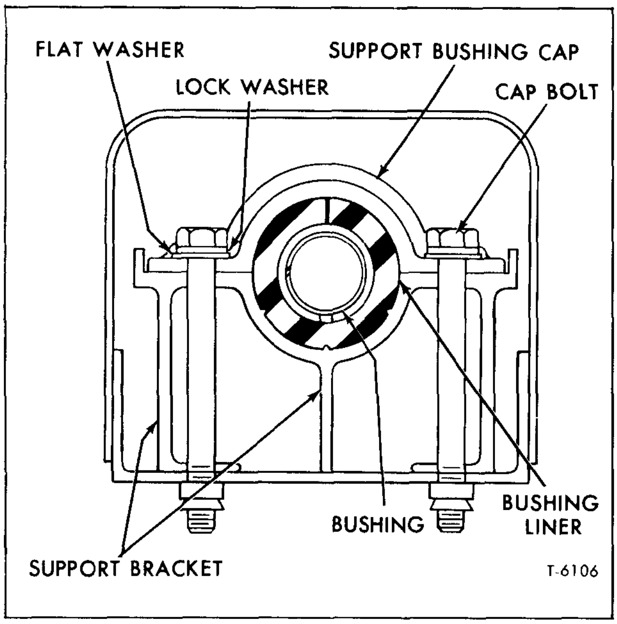


Figure 24—Steering Shaft Lower Support Bushing Assembly (Alum. Tilt)

NOTE: Two more bushings (1), new cork washers (3), and snap rings (2) will be installed on center cross (4) when the intermediate shaft is installed in the vehicle.

4. Install lubrication fitting (13) in center cross (14) and position center cross in yoke shaft (9).
5. Position clamp yoke (15) on center cross (14).
6. Place two bushings (11) and two new cork washers (10) on center cross (14); then secure with two snap rings (12).
7. Repeat Step 6 and install two more bushings (11) and two new cork washers (10). Secure parts with two snap rings (12).
8. Position dust cap (8), metal washer (5), and new felt washer (7) on yoke shaft (9); then insert yoke shaft in yoke tube and sleeve assembly (6). Bend tangs of dust cap (8) down against yoke tube.

STEERING COLUMN AND UPPER SHAFT ASSEMBLY

1. If previously removed, press lower bearing into mast jacket.
2. Position directional signal control assembly in housing and attach with screws. Tighten screws to 30 to 40 inch-pounds torque. Install directional signal control lever.
3. Place "stop" clamp on lower end of upper shaft and install bolt, nut, and lock washer loosely.
4. Install washer, spring, spring seat, and seal on lower end of upper shaft.
5. Position center cross on upper shaft yoke in intermediate shaft tube yoke. Install two new cork washers, two tube yoke bushings, and two snap rings.
6. Install bearing sleeve in column upper bearing.

INSTALLATION (Fig. 21)

1. Position steering column, upper and intermediate steering shaft, steering column seal, and seal plate in vehicle.
2. Position intermediate shaft clamp yoke on steering gear worm shaft with match marks aligned.
3. Raise mast jacket into position and install bolts attaching steering column to support and braces. Install steering column to floor seal and retainer.
4. If vehicle is equipped with a trailer brake hand control valve, position control valve on steering column and install mounting clamp to secure.
5. Install steering wheel as described under "Steering Wheel Replacement" earlier.
6. Adjust "stop" on lower end of upper shaft to allow 0.005" (min.) to 0.030" (max.) axial movement of shaft assembly and tighten stop bolt nut to 5 to 6 foot-pounds torque.

CAUTION: This clearance must be maintained to prevent excessive axial chucking of upper steering shaft or binding of upper steering shaft bearings.

STEERING COMPONENT FASTENERS

NOTE: ALL STEERING COMPONENT ATTACHMENTS, ARE IMPORTANT ATTACHING PARTS IN THAT THEY COULD AFFECT THE PERFORMANCE OF VITAL COMPONENTS AND SYSTEMS, AND/OR COULD RESULT IN MAJOR REPAIR EXPENSE. THEY MUST BE REPLACED WITH PARTS OF THE SAME PART NUMBERS OR WITH EQUIVALENT PARTS IF REPLACEMENT BECOMES NECESSARY. DO NOT USE REPLACEMENT PARTS OF LESSER QUALITY OR SUBSTITUTE DESIGN. TORQUE VALUES MUST BE USED AS SPECIFIED DURING REASSEMBLY TO ASSURE PROPER RETENTION OF THESE PARTS.

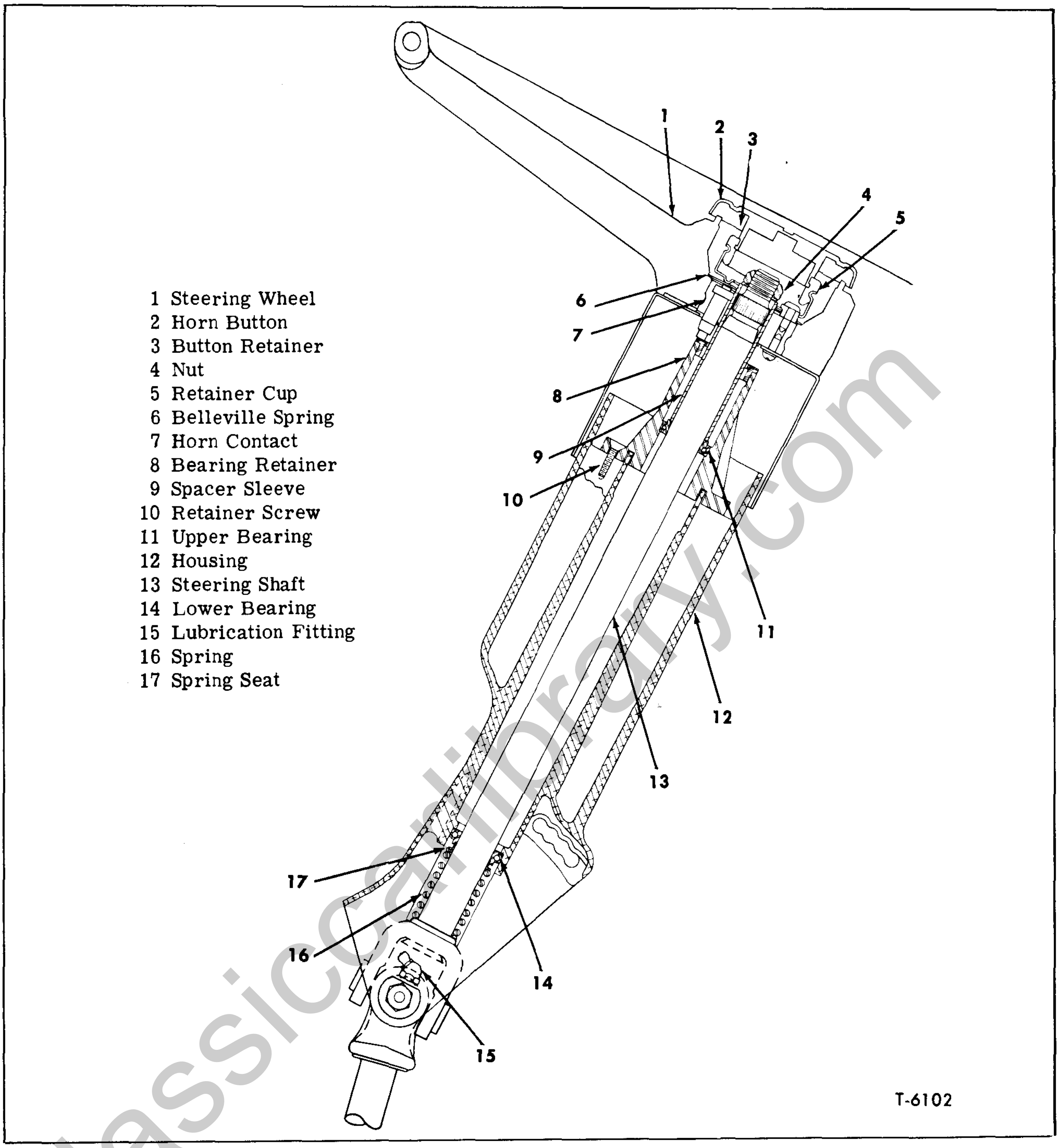


Figure 25—Upper Steering Column and Shaft (Alum. Tilt)

STEERING COLUMN AND SHAFT ASSEMBLY REPLACEMENT (ALUM. TILT) (FIG. 23)

REMOVAL

1. Remove steering wheel as described previously under "Steering Wheel Replacement."
2. Scribe an alignment mark on lower steering shaft clamp yoke and steering gear worm shaft to ensure installation in same relative position.
3. Remove bolt and nut which attach steering shaft clamp yoke to steering gear worm shaft. Gently tap steering shaft clamp yoke upward, removing clamp yoke from the worm shaft.
4. Remove steering column trim panel inside cab, which is attached with four screws, flat washers, and lock washers.

5. Remove seal retainer and seal at base of steering column support, after removing four attaching screws and washers.

6. Remove four bolts which attach lower steering column bushing retainer cap and support bracket

7. Remove four bolts, which attach tilt column quick release bracket to steering column support and withdraw the complete steering column and steering shaft assembly from inside the cab. Housing can be readily removed as explained later under "Steering Column and Lower Bearing Replacement."

INSTALLATION

1. Position steering column and shaft assembly in cab and install four bolts which attach tilt column quick release bracket to steering column support. Tighten bolts to 25 to 30 foot-pounds torque.

2. Attach lower steering column support bracket and bushing retainer cap with four bolts and lock washers. Tighten bolts to 20 to 25 foot-pounds torque.

3. Install seal and seal retainer at base of steering column support.

4. Place lower steering shaft clamp yoke onto steering gear worm shaft, aligning scribed marks made previously for proper location.

5. Tap steering shaft clamp yoke onto worm shaft until bolt hole is aligned with undercut section of worm shaft. Install bolt and nut and tighten to 40 to 50 foot-pounds torque.

6. Place steering column trim panel in position and install four screws, flat washers and lock washers.

7. Install steering wheel as described previously under "Steering Wheel Replacement."

STEERING SHAFT LOWER SUPPORT BUSHING REPLACEMENT (ALUM. TILT) (FIG. 24)

REMOVAL

1. Remove four retainer cap bolts, cap, and support bracket.

2. Carefully spread rubber liner and nylon bushing to remove from steering shaft.

INSTALLATION

1. Lubricate inside of nylon bushing with "S17" Special Grease. (Refer to LUBRICATION (SEC. 0) for definition of this lubricant.)

2. Spread bushing and position on shaft.

3. Spread rubber liner and position around bushing, being sure to align notch in rubber liner to raised section of the bushing.

4. Place support bracket in position against cab steering column support.

5. Position cap over rubber liner, being careful to contain the ends of the liner within the retainer ribs of the cap.

6. Install the four cap bolts and lock washers and tighten to 20 to 25 foot-pounds torque.

STEERING COLUMN UPPER BEARING REPLACEMENT (ALUM. TILT)

REMOVAL

1. Remove steering wheel as directed previously under "Steering Wheel Replacement."

2. Disconnect horn wire terminal at horn contact ring.

3. Remove horn contact ring from top of steering column bearing support, by prying evenly around contact ring with a screwdriver.

4. Remove spacer sleeve from steering shaft by spreading slightly and lifting up simultaneously.

5. Remove three screws which attach bearing support to column base and remove support assembly.

6. Extract bearing from support by tapping with a light hammer and drift pin or a round object that will bear evenly on the outside race only.

NOTE: DO NOT exert pressure on the inside race of the bearing as this will damage bearing.

INSTALLATION

1. Insert bearing into support with extension side up. Press or tap bearing into support by applying pressure evenly to the outer race of the bearing.

NOTE: DO NOT exert pressure on the inner race of the bearing as it could cause damage to the bearing.

2. Position the support to steering column base, noting location of the horn wire cut out, then install three attaching screws. Torque screws to 20 to 25 inch-pounds.

3. Press horn contact ring assembly evenly into top of support, keeping horn wire connection in proper alignment, and connect horn wire.

4. Position spacer sleeve on steering shaft and apply pressure downward until it lightly contacts bearing inner race.

5. Install steering wheel as described previously in "Steering Wheel Replacement."

STEERING COLUMN HOUSING AND LOWER BEARING REPLACEMENT (ALUM. TILT)

REMOVAL

1. Remove steering wheel as explained previously under "Steering Wheel Replacement."

2. Remove steering shaft upper bearing retainer assembly as explained previously under "Steering Column Upper Bearing Replacement."

3. Remove four screws and washers which

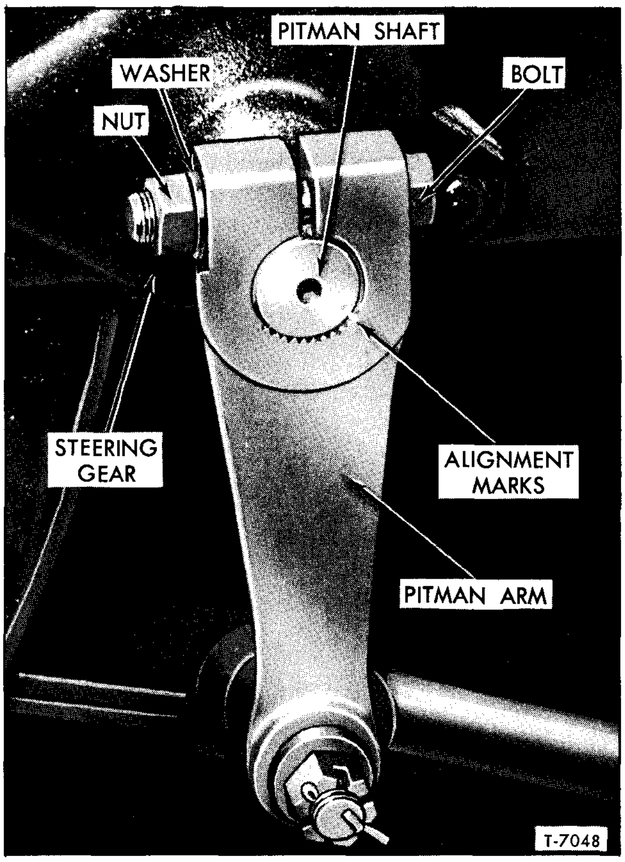


Figure 26—Pitman Arm Installed (Conventional Cab Models)

attach steering column trim panel to column support. Remove trim panel.

4. Remove four bolts, lock washers and flat washers which attach steering column tilt quick release bracket to steering column support. Support column assembly to prevent housing and shaft assembly from pivoting into driver's seat.

5. Lift column housing from steering shaft. If desired, lower bearing seat and spring (fig. 25) can be removed from shaft.

6. Lower bearing can be removed from the steering column housing by tapping on the outer race, of the bearing with a long punch, from the opposite end of the housing.

INSTALLATION

1. Position bearing, with the flat side inserted first into the bore of the housing.

2. Press or tap the bearing evenly into place using a round tubular tool that will exert force on the outer race of the bearing.

3. Install lower bearing seat and spring (fig. 28) if previously removed.

4. Slide column housing and bearing assembly onto steering shaft.

5. Align steering column tilt quick release bracket holes with steering column support and install four attaching bolts, lock washers, and flat washers. Tighten bolts to 25 to 30 foot-pounds torque.

6. Position steering column trim panel in place and install four attaching screws and washers.

7. Install steering shaft upper bearing retainer assembly as explained previously under "Steering Column Upper Bearing Replacement."

8. Install steering wheel as explained previously under "Steering Wheel Replacement."

STEERING WHEEL "CLUNKING" NOISE

When steering wheel "clunking" noise is experienced and is accompanied by up-and-down movement of the steering wheel, it is possible that the mast jacket clamps and lower steering shaft clamp need adjusting. The "clunking" is caused by up-and-down movement of upper and lower shaft joints and can be eliminated as follows:

1. Loosen mast jacket clamps at dash and firewall.

2. Push steering wheel down until all up and down movement has been removed.

3. Tighten clamp at dash; then tighten clamp at fire wall (if used).

4. Adjust "stop" clamp at bottom of steering shaft to allow 0.005" to 0.030" up and down movement of the upper shaft assembly (fig. 21).

NOTE: If "clunking" still exists, the yoke and sleeve assemblies should be disassembled, inspected for wear, and replaced if necessary. This is an important safety procedure which will prevent internal steering shaft joint interference.

MECHANICAL STEERING GEAR REPLACEMENT

NOTE: All steering gear, and pitman arm attaching bolts and nuts are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with parts of the same part numbers or with equivalent parts if replacement becomes necessary. Do not use replacement parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

If the steering gear cannot be properly adjusted, or if during adjustment procedures "lumpy" or "rough" action is noticed, the steering gear must be removed from the vehicle and overhauled. The steering gear must be removed from the vehicle for all overhaul procedures.

STEERING GEAR REMOVAL

1. Disconnect steering linkage from Pitman arm.
2. Scribe an alignment mark on steering gear worm shaft and clamp yoke or coupling on steering gear lower or intermediate shaft.
3. Remove bolt attaching lower or intermediate shaft clamp yoke or coupling to steering gear worm shaft.
4. On conventional cab models which have Pitman arm retained with a clamp bolt, nut, and special hardened washer, scribe an alignment mark across Pitman arm and shaft (fig. 26). Remove Pitman arm.

   On all other vehicles, remove Pitman arm nut and lock washer; then using puller (J-3186), remove Pitman arm.
5. Remove bolts, nuts, and lock washers, which attach steering gear to frame and remove steering gear.

STEERING GEAR INSTALLATION

1. Position steering wheel in straight-ahead position and steering gear in center position. Mark on worm shaft should be in 6 o'clock position.
2. Position steering gear on frame side member, and at the same time slide the worm shaft into the clamp yoke or cospling on steering lower or intermediate shaft.

   IMPORTANT: Check to make sure match marks on lower or intermediate shaft clamp yoke or coupling and steering gear worm shaft are aligned.
3. Install bolts, nuts, and washers which attach steering gear to frame. Tighten bolts to torque listed in "Specifications" at end of this section.
4. Attach lower or intermediate shaft clamp yoke or coupling to steering gear worm shaft with bolt; or bolt, nut, and washer. Tighten bolt or nut to torque listed in "Specifications" at end of this section.
5. On conventional cab models which have Pitman arm retained with a clamp bolt, nut, and washer, install Pitman arm on shaft with match marks aligned. Install bolt, nut, and washer and tighten to torque specified in "Specifications" at end of this section.

   On all other vehicles Pitman arm and Pitman shaft have matching blank serrations which must be aligned. With Pitman arm and shaft aligned, press Pitman arm onto shaft and install washer and Pitman shaft nut. Tighten nut to torque specified in "Specifications" at end of this section.

STEERING COLUMN SLIP SPLINE

NOTE: Whenever the slip spline is disassembled, be careful to align the locating arrows on each half when reassembling (fig. 27). This is necessary to ensure proper universal joint phasing.

DISASSEMBLY

1. Pry the dust cap tabs out of the retaining groove and pull the two halves apart.
2. Remove the split nylon retaining washer, split seal, and dust cap from shaft.

ASSEMBLY

1. Position the dust cap on the male splined shaft so that retaining tabs face the groove of the mating female shaft.
2. Install the split nylon washer by carefully spreading the split ends over the shaft.
3. Carefully spread the felt seal over the shaft, noting that the split nylon washer will contact both the dust cap and the seal.
4. Thoroughly clean both male and female spline surfaces and lubricate with chassis grease before assembly.
5. Slide the two shafts together taking note that the alignment arrows are matched (see fig. 27).
6. Bend the dust cap retaining tabs into the groove.

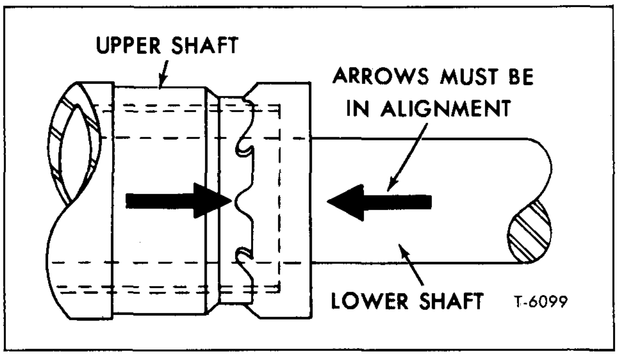


Figure 27—Steering Shaft Lower Slip Spline

PITMAN ARM REPLACEMENT (CLAMP BOLT TYPE)

REMOVAL

1. Remove cotter pin, nut, and washer from connecting link to Pitman arm ball stud.

2. Remove ball stud from Pitman arm by striking with a hammer on edge of Pitman arm adjacent to ball stud, while using a large hammer as a back-up tool on the opposite edge of arm.

NOTE: DO NOT hammer on the Pitman arm without supporting, or backing arm up with a heavy object as damage could occur to steering gear.

3. Remove Pitman arm clamp bolt nut, washer, and bolt.

4. If necessary, insert a wedge-shaped tool into the Pitman arm split and spread slightly. Remove Pitman arm from shaft by tapping lightly on the back-side of the Pitman arm.

INSTALLATION

1. Note direction of connecting link ball stud tapered hole. Small end of the tapered hole should face toward left side of the vehicle.

2. Position Pitman arm on the sector shaft, being careful to align serrations, and lightly tap arm until Pitman arm clamp bolt hole and groove in sector shaft are in alignment.

NOTE: DO NOT hammer excessively to force Pitman arm onto sector shaft. It may be necessary to slightly spread the Pitman arm to facilitate installation.

3. Install bolt, washer, and nut and tighten nut to 90-110 foot-pounds torque.

4. Connect connecting link ball stud to Pitman arm, install washer, and tighten nut to 125-150 foot-pounds torque. Advance to next slot and install new cotter pin.

PITMAN ARM REPLACEMENT (TAPERED SHAFT TYPE)

REMOVAL

1. Remove cotter pin and nut from connecting link to Pitman arm ball stud.

2. Remove ball stud from Pitman arm by striking with a hammer on edge of Pitman arm adjacent to ball stud, while using a larger hammer as a back-up tool on the opposite edge of arm.

NOTE: DO NOT hammer on the Pitman arm without supporting, or backing arm up with a heavy object as damage could occur to steering gear

3. Remove Pitman shaft to Pitman arm retaining nut and lock washer.

4. Using puller (J-21143), remove Pitman arm

NOTE: Be sure to inspect Pitman shaft and internal serrations for worn or damaged areas.

INSTALLATION

1. Position Pitman arm on Pitman shaft, being careful to properly align serrations.

2. Install lock washer and nut and torque to "Specifications" listed at end of this section.

3. Install connecting link ball stud to Pitman arm and torque nut to "Specifications" listed at end of this section.

4. Install cotter pin in connecting link ball nut.

SPECIFICATIONS

Make .... Saginaw Steering Gear Division
Type .... Recirculating Ball and Sector Nut
Steering Gear Adjustments:
  Worm Bearings
    Pull to Keep Wheel Moving .... 1½ to 2 Lbs.
    End Cover Shim Thickness
      (568-D-Gear Only) .... 0.002", 0.005", 0.010", 0.030"
  Sector Gear Lash
    Pull Over Center .... 2¾ to 3¼ Lbs.
    Lash Adjuster Shim Thickness .... 0.063", 0.065"
      0.067", 0.069"

Idler Lever Bushing	Width	I.D.	O.D.
Tilt Cab Models	0.740"	1.125"	1.312"
	0.760"	1.126"	1.313"

TORQUE SPECIFICATIONS

LOCATION	TYPE OF PART	TORQUE (FT.-LBS.)
Steering Wheel Nut	Nut	45-50
Steering Column Pivot Bolt Conventional Cab Models Alum. Tilt	Bolt	8-10
Steering Column Release Bolt Conventional Cab Models	Nut	8-10
Support Bracket to Instrument Panel Steel Tilt Cab Models	Bolt	20-25
Steering Column Support Bearing Cap Bolts—Alum. Tilt	Bolt	20-25
Mast-Jacket Mounting Clamp to Support Bracket Tilt Cab Models	Bolt	15-20
Steering Upper Shaft Lower Bearing Stop Bolt	Nut	8-12
Steering Shaft Coupling to Worm Shaft Clamp	Bolt	35-40
Steering Shaft Slip Yoke to Worm Shaft Clamp Bolt	Nut	40-50
Intermediate Shaft to Worm Shaft Clamp Bolt Series TV-70	Nut	35-45
Except Series TV-70	Nut	40-45
Steering Upper Shaft to Lower Shaft Clamp Bolt	Nut	30-35
Drag Link to Pitman Arm Stud*	Nut	125-150
Drag Link to Steering Arm Stud*	Nut	125-150
Drag Link to Idler Lever Stud*	Nut	125-150
Drag Link Clamp Bolt		
Except F-070 or F-090 Front Axle	Nut	65-75
With F-070 or F-090 Front Axle	Nut	55-56
Connecting Rod to Pitman Arm Stud*	Nut	125-150
Connecting Rod to Steering Arm Stud*	Nut	125-150
Idler Link to Pitman Arm Stud*	Nut	125-150

LOCATION	TYPE OF PART	TORQUE (FT.-LBS.)
Idler Link to Idler Lever Stud*	Nut	125-150
Idler Lever to Frame Stud	Nut	110-130
Idler Lever to Idler Lever Bracket Stud*	Nut	175
Tie Rod to Steering Arm Stud*		
Except F-070 Front Axle	Nut	125-150
With F-070 Front Axle	Nut	230-250
Tie Rod End Clamp Bolt		
Except F-070 Front Axle	Nut	60-80
With F-070 Front Axle	Nut	80-100
Steering Arm to Axle Stud*		
Except F-070 Front Axle	Nut	400
With F-070 Front Axle	Nut	180-240
Steering Gear to Frame Bolt		
Conventional Cab Models	Nut	50-60
Steel Tilt Cab Models and Alum. Tilt	Nut	90-110
Steering Gear:		
Lash Adjuster Screw	Nut	25-35
Side Cover to Housing	Bolt	25-35
End Cover to Housing	Bolt	35-45
Worm Bearing Adjuster Screw	Nut	70-110
Back-up Adjuster Screw	Nut	30-50
Pitman Arm to Shaft:		
553-D-17	Nut	185-215
553-D-81 Pinch Bolt	Nut	100-110
554-D-6 Pinch Bolt	Nut	100-110
568-D-31	Nut	250-300
568-D-45	Nut	250-300
568-D-46	Nut	250-300
568-D-73	Nut	250-300
555-D-37 Pinch Bolt	Nut	90-110

*Tighten to Specified Torque, Then Advance to Next Aligning Slot and Install New Cotter Pin.

NOTE: All steering component attachments are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with parts of the same part numbers or with equivalent parts if replacement becomes necessary. Do not use replacement parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

POWER STEERING

GENERAL

The power steering system provides automatic hydraulic assistance to the turning effort applied to the mechanical steering system.

On all models, except those equipped with the F-160 front axle, the power steering system consists of a control valve, power cylinder and a hydraulic pump used in conjunction with the steering gear.

A typical power steering system used on conventional cab models is shown in figure 1 and a typical power steering system as used on steel tilt cab models is shown in figure 2.

NOTE: On Series 70 and 80 tilt cab models, a connecting rod is used between the Pitman arm and left steering arm and an axle-mounted power cylinder is used.

On some models equipped with the F-160 front axle, the power steering system consists of a control valve, hydraulic pump, and two side-mounted power cylinders. The left-hand cylinder socket is attached to the Pitman arm and the right-hand cylinder socket is attached to an idler arm.

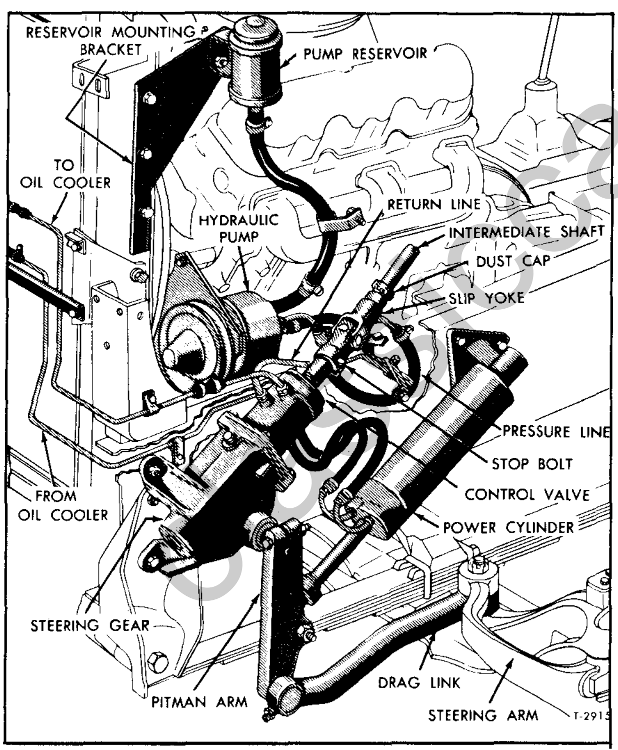


Figure 1—Power Steering System (Conv. Cab Models) (Typical)

The power steering system is a complete Inline unit. The steering shaft, hydraulic valve, worm, and ball nut are in a line, making a compact, space-saving steering gear. The recirculating ball-type mechanical steering gear is used in conjunction with the control valve.

The power steering will not operate without driver guidance; therefore when turning effort is relieved, the front wheels return to neutral or straight ahead position.

On all models except those equipped with the F-160 front axle, the power cylinder is actuated by operation of the control valve which supplies hydraulic fluid to either side of the power cylinder piston as required, depending on the position of the valve. The pressure used to operate this system is supplied by either a vane-type or slipper-type fluid pump.

On some vehicles equipped with the F-160 front axle, the power cylinder is actuated by operation of the control valve which supplies hydraulic pressure to a junction block which in turn supplies hydraulic fluid to the right and left power cylinders as required, depending on the position of the valve. The pressure used to supply this system is supplied by a vane-type oil pump which is belt-driven from the engine crankshaft pulley, or direct gear driven, in conjunction with other accessories.

If for any reason the power steering system should fail, the control valve "locks up" and the steering gear operates manually, giving the driver full control of the vehicle. Response of the steering gear in effort applied to the steering wheel has been greatly increased. This fast response gives the driver greater control of the vehicle.

The 568-DV type steering gears are equipped with a worm nut "stop," countersunk at each end of the worm shaft, to prevent the worm ball nut from bottoming on extreme turns. A back-up adjuster is used to keep the worm shaft from flexing up and down.

MAINTENANCE

The power steering system requires little maintenance. However, the hydraulic system should be kept clean to insure maximum operating performance and trouble-free service. Periodic inspection to check for leaks should also be made.

At regular intervals the pump hydraulic fluid level in the reservoir should be checked and fluid added when required. Refer to LUBRICATION (SEC. 0) for type of fluid to be used, method, and intervals for filling.

On all hydraulic pump models, the fluid reservoir either encases the pump or is mounted on top of the pump. An additional reservoir is mounted on a bracket attached to the radiator support on conventional cab models or to the transmission control island panel front support on tilt cab models.

When the slightest evidence of dirt, sludge, or water is discovered in the system, drain and refill with clean hydraulic fluid recommended in LUBRICATION (SEC. 0). To drain system, disconnect fluid lines at power cylinder. Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled after adding fluid. Bleed system as directed later in this section under "Bleeding Hydraulic System." Should the power steering system become inoperative due to loss of hydraulic fluid, pump pressure line should be re-routed from pump outlet directly back to pump reservoir or disconnect drive belt.

IMPORTANT: Do not operate pump without fluid in pump reservoir.

The hydraulic pump, control valve, and power cylinder do not require adjustment on the vehicle. The only adjustments are on the steering linkage. Adjustment of these parts are normally required only when the units have been removed or disconnected.

NOTE: These adjustments, with the exception of the power cylinder piston rod end, are the same as previously described in "MECHANICAL STEERING" of this group.

Wheel alignment must be maintained to proper specifications. Refer to "FRONT END ALIGNMENT" (SEC. 3A) of this manual for proper procedures for checking front end alignment. Improper tire inflation will also affect operation of the power steering. The tires, therefore, should be checked at regular intervals.

Because of the power assist from the power steering system it is more difficult to detect defects in the steering system. Therefore, periodic maintenance is very important on a vehicle having power steering.

BLEEDING HYDRAULIC SYSTEM

When a power steering pump or power cylinder has been installed or a disconnected oil line has been reconnected, the air that has entered the system must be bled out before the vehicle is again operated. If air is allowed to remain in the hydraulic fluid system noisy and unsatisfactory operation of the steering system will result. Bleed air from the hydraulic system as follows:

NOTE: When hydraulic fluid is added to power steering system, fluid should be poured through a 200 mesh wire screen. Use only the hydraulic fluid recommended in LUBRICATION (SEC. 0).

1. Fill pump fluid reservoir to proper level and let fluid remain undisturbed for about two minutes.
2. Raise front end of the vehicle so that front wheels are off the ground.
3. Turn wheels to right and left to wheel "stops" to eliminate air pockets in the power cylinder. Continue this operation until fluid in reservoir stops bubbling. Maintain fluid level during this operation.
4. Start the engine and run at idle for two minutes. turn wheels to right and left as before.

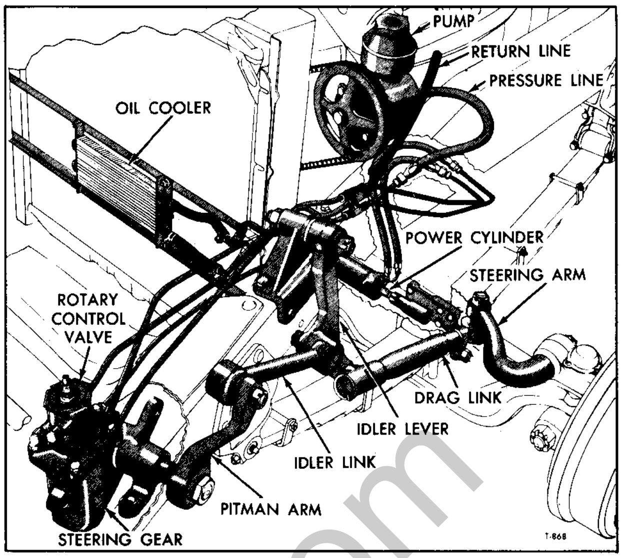


Figure 2—Power Steering System (Steel Tilt Cab Models) (Typical)

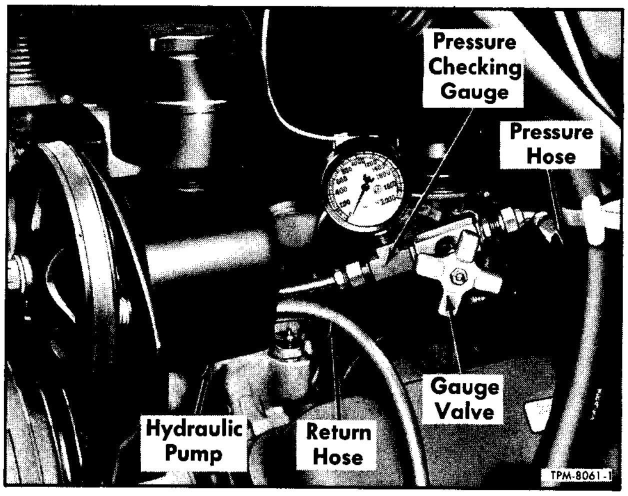


Figure 3—Checking Pump Hydraulic Pressure (Vane Type Pump) (Typical)

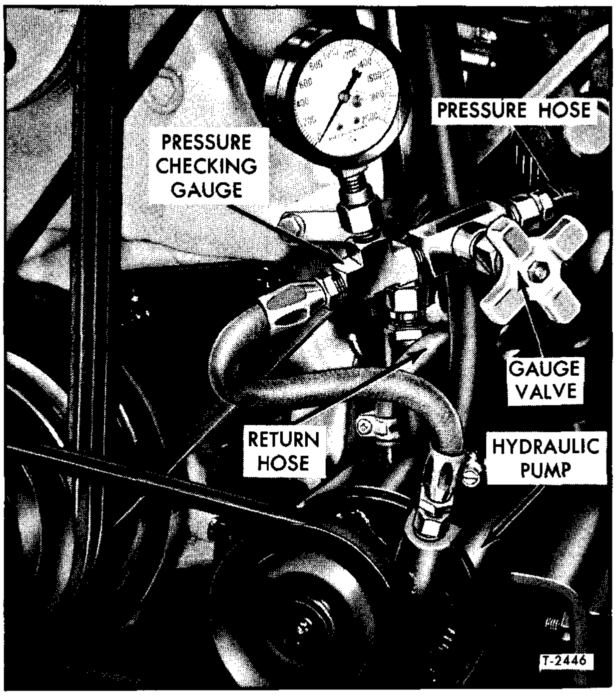


Figure 4—Checking Pump Hydraulic Pressure (Slipper Type Pump) (Typical)

DO NOT HIT THE WHEEL STOPS. Recheck fluid level. Recheck hoses and connections for leaks. Continue this operation until fluid in reservoir is clear.

5. Increase engine speed to approximately 1500 rpm and continue running at this speed until all signs of air bubbles cease to appear in reservoir. Turn wheels (off the ground) to right and left. DO NOT HIT THE WHEEL STOPS.

6. Lower the vehicle and turn wheels on the ground. Recheck for leaks.

7. Check fluid level in reservoir and refill.

HYDRAULIC PRESSURE TEST

VANE-TYPE HYDRAULIC PUMPS

1. Disconnect pressure hose from fitting at the hydraulic pump. Connect a 0 to 2000 psi pressure gauge (J-22181) between the pressure hose and the pump pressure port. Leave valve in pressure gauge line open (fig. 3).

2. Bleed steering hydraulic system to remove all air from pressure line as directed previously under "Bleeding Hydraulic System."

3. Start engine and run at idle speed. Turn wheels through normal operating range several times until the hydraulic fluid temperature reaches 170°F. When fluid temperature reaches 170°F., close valve in pressure gauge line and observe reading on pressure gauge. Pressure reading should be within limits listed under "Pressure Relief Valve" in "Specifications" at end of this section.

4. Open the valve in pressure gauge line. Turn wheels to extreme right and left against "stops" (with wheels on ground). At extreme right or left position, the pressure reading should be within limits listed under "Pressure Relief Valve" in "Specifications" at end of this section.

SLIPPER-TYPE HYDRAULIC PUMP

1. Disconnect hydraulic pump to steering gear pressure line at pump. Connect a 0 to 2000 psi pressure gauge (J-22181) to the pump outlet; then connect a shut-off valve between the pressure gauge and pressure line (fig. 4). Make sure all connections are tight and that shut-off valve is fully open.

NOTE: The pressure gauge must be installed between the pump and the shut-off valve.

2. Start the engine and run for several minutes at idle speed. Turn wheels from right to left several times to expel all air from system and to bring fluid temperature to approximately 170°F.

3. Close shut-off valve and observe pressure gauge. Pressure should be 1000 to 1100 psi.

NOTE: Do not close valve for more than a few seconds, as this would increase fluid temperature and cause excessive pump wear.

4. Open shut-off valve; then turn wheels to extreme right and left with wheels on ground. At extreme positions, the maximum pressure reading should be within above limits.

5. If pressure is greater than 1100 psi or less than 1000 psi, replace the pressure relief valve and repeat the test. If pressure is still not within limits specified, remove the pump and disassemble.

PUMP DRIVE BELT

MAINTENANCE

The drive belt must be kept at proper tension. A loose belt will reduce output of the hydraulic pump, while a tight belt will cause eventual bearing failure. A regular, periodic inspection is recommended to check condition of drive belt. Replace belt if frayed or badly worn.

ADJUSTMENT

NOTE: When adjusting a new drive belt, adjust tension to "New" belt specifications, turn engine over several times, then reset belt to "New" specifications specified below:

1. Adjusting Poly-V Belt Using Strand Gauge (J-23586)

NOTE: Gauge should be placed at the center of the greatest span of the belt.

a. Loosen pump mounting bolts.

b. If "Used" belt, position pump to obtain 78 to 88 pounds.

c. If "New" belt, position pump to obtain 103 to 113 pounds.

d. Tighten pump attaching bolts firmly.

NOTE: A Poly-V belt is considered "Used" after one-hour's operation or approximately 50 miles operation.

2. Adjusting Ordinary V-Belt Using Strand Gauge (J-23573)

NOTE: Gauge should be placed at the center of the greatest span of the belt.

a. Loosen pump mounting bolts.

b. If "Used" belt, position pump to obtain 80 to 90 pounds.

c. If "New" belt, position pump to obtain 120 to 130 pounds.

d. Tighten pump attaching bolts firmly.

NOTE: A V-belt is considered "Used" after two-hour's operation or approximately 50 to 100 miles operation.

TUBES, HOSES, AND FITTINGS

Stationary tubes and flexible hoses are used to carry hydraulic fluid through the power steering system. These tubes and hoses connect the steering gear to the power cylinder and hydraulic pump.

NOTE: On some vehicles equipped with the F-160 front axle, and junction block is used between the control valve and right and left power cylinders. Tag each tube or hose prior to removal to insure installation in same relative location.

All tubes, hoses, and fittings should be inspected for leakage at regular intervals. Fittings must be tightened to torque listed in "Specifications" at end of this section. Make sure clips, clamps, and unions supporting tubes and hoses are in place and properly secured.

POWER STEERING GEAR AND CONTROL VALVE

NOTE: These control valve and Power Steering Gear fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

The 553-DV and 568-DV type power steering gear assemblies are basically the same except for size and mounting. The 568-DV type steering gear incorporates a back-up adjuster to prevent the worm shaft from flexing up and down and "stops" are countersunk at each end of the worm shaft to prevent the ball nut from bottoming on extreme turns. Refer to "Model Application" at end of this section for steering gear application.

CONTROL VALVE

The power steering system control valve is mounted on top of the steering gear housing and is activated by a torsion bar that tends to keep the valve in neutral position. Should the torsion bar break, the spool and valve body "lock up" into a complete unit that then operates mechanically.

The valve shown in figure 5 is an open-centered, rotary-type, three-way valve. The spool is held in the neutral position by means of the torsion bar. The spool is attached by means of a stud fastened to one end of the torsion bar and the valve body to the other end. Twisting of the torsion bar allows the spool to displace in relation to the valve body, thereby operating the valve.

CONTROL VALVE OPERATION

When the valve is in neutral or straight-ahead position, the fluid flows from pump through the open-center valve, and back to pump reservoir, without traveling through the power cylinder. This open-center position of the valve reduces pump losses to a minimum. Valve is in open-center position at all times except when turning. The power cylinder is always full of fluid, which acts as a cushion to absorb shocks so that they are not transferred to the driver. This fluid lubricates all of the internal components of valve, making it unnecessary to lubricate the valve.

With the steering wheel turned to the right, the torsion bar is deflected, changing the relationship of the spool grooves and valve body grooves with each other. The right-turn grooves of the spool are closed off from the return grooves and opened to the pressure grooves. The left-turn grooves of the spool are closed off from the pressure grooves and opened to the return grooves. This causes the fluid to flow into the appropriate half of the power cylinder, overcoming the tire friction in that direction. The fluid in the opposite end of the cylinder is simultaneously forced out through the valve and back to the pump reservoir.

The greater the resistance to turning between the road surface and front wheels, the more the valve spool is displaced and the higher the fluid pressure is on the resisting side of the piston. Since the amount of valve displacement and consequently the amount of hydraulic pressure built in the cylinder is dependent upon the resistance to turning, the operator is assured of the proper amount of smooth hydraulic assist at all times. The instant the operator stops applying steering effort to the steering wheel, the valve is returned to its neutral position by the torsion bar. The fluid pressure is equalized on both sides of the piston when the torsion bar returns to neutral position. The wheels return to a straight-ahead position due to the steering geometry of the vehicle.

When the steering wheel is turned to the left, the fluid flow in the valve is the same as when making a right-turn but takes place in the opposite direction. Parking pressure, the most difficult of turning conditions, should range from 900 to 1000 psi on all vane type hydraulic pump models except 235-P-124, 235-P-43 and 235-P-47. Parking pressure should range from 1100 to 1200 psi on pump models 235-P-43, 235-P-124, and 235-P-47. On slipper-type pump models, parking pressure should range from 1000 to 1100 psi, depending upon the road surface, vehicle weight, and pressure relief setting in the pump. During normal straight-ahead driving, the steering wheel effort will be approximately the same as manual effort under the same conditions. The control valve will give the driver a smooth transition through the driving range of wheel effort and will retain the "road-feel necessary for effortless driving."

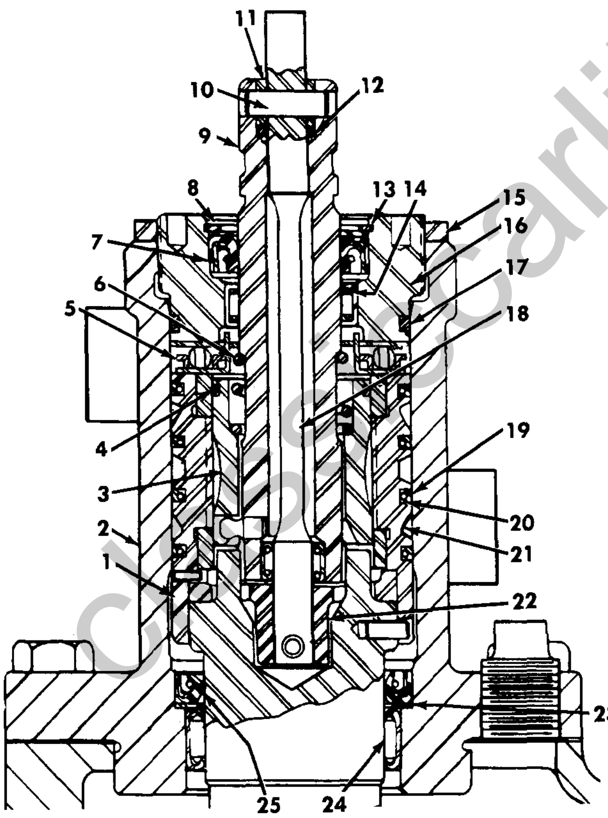
POWER STEERING GEAR REPLACEMENT

REMOVAL

1. Mark steering gear worm shaft and coupling or clamp yoke on steering gear lower or intermediate shaft so they can be assembled in same position when steering gear is reinstalled.

2. On conventional cab models, disconnect drag link and power cylinder socket end from Pitman arm.

On tilt cab models, remove cotter pin and nut attaching connecting rod or idler link to Pitman arm. Use a hammer to tap connecting rod or idler link loose from Pitman arm.



1 Valve Body
2 Top Cover
3 Valve Spool
4 Valve Spool Dampener
5 Upper Thrust Bearing
6 Spool Spring
7 Stub Shaft Seal
8 Seal Retaining Ring
9 Stub Shaft
10 Torsion Bar Pin
11 Torsion Bar Sleeve
12 Torsion Bar Seal
13 Seal Back-up Washer
14 Needle Bearing
15 Adjuster Plug Lock Nut
16 Adjuster Plug
17 O-ring Seal
18 Torsion Bar
19 Valve Body Ring
20 Back-up Seal
21 Valve Assembly
22 Torsion Bar Cap
23 Back-up Washer
24 Worm Bearing
25 Worm Oil Seal

TPM-9060

Figure 5—Power Steering Control Valve (Type 553-DV) (Typical)

3. On all models, remove steering shaft to steering gear worm shaft clamp bolt. Bend tangs on dust cap away from the yoke tube, then raise shaft and yoke off steering gear worm shaft.

4. Remove Pitman arm pinch bolt, nut, and special washer; or the Pitman arm to shaft nut and washer. Use puller (J-21143) to remove the Pitman arm.

5. Drain as much fluid as possible from the steering gear.

6. Disconnect control valve to pump return tube, pump to control valve pressure tube, and control valve to power cylinder right and left turn tubes from control valve ports.

IMPORTANT: Cover or plug exposed tubes and ports to prevent dirt from entering the hydraulic system.

7. Remove bolts, nuts, and washers which attach steering gear assembly to frame left side member. Remove steering gear and control valve assembly.

INSTALLATION

1. Position steering wheel in straight-ahead position and steering gear in center position.

2. Position steering gear on frame left side member, at the same time sliding the worm shaft into the clamp yoke or coupling. Check to make sure the alignment marks are in line.

3. Install bolts, nuts, and washers attaching steering gear to frame left side member. Tighten bolts to torque listed in "Specifications."

4. Attach intermediate shaft clamp yoke or coupling to steering gear worm shaft with bolt, nut, and washer. Tighten bolt to torque listed in "Specifications" at end of this section.

5. Move dust cap down on yoke tube and bend tangs down to secure in position.

6. If not previously installed, position Pitman arm on Pitman shaft.

NOTE: Pitman arm and shaft have matching blank serrations which must be aligned. Align previously made scribe marks on Pitman arm and shaft, then install Pitman arm on shaft and secure with pinch bolt, special hardened washer, and nut. Tighten nut to torque listed in "Specifications" at end of this section.

On all other vehicles, install washer and nut to attach Pitman arm to Pitman shaft. Tighten nut to torque listed in "Specifications."

7. On conventional cab models, connect drag link to Pitman arm. Adjust drag link as explained in "MECHANICAL STEERING" section of this manual. Connect power cylinder end socket assembly to Pitman arm.

8. On tilt cab models, connect idler link or connecting rod to Pitman arm and attach with nut. On Alum. Tilt see mechanical installation. Tighten nut to 125 to 150 foot-pounds, advance to the next aligning slot and install new cotter pin to secure nut.

9. Connect control valve-to-pump return tube, pump-to-control valve pressure tube, and right- and left-turn tubes from power cylinder or junction block to control valve ports. Tighten fittings to torque recommended in "Specifications" at end of this section.

10. Bleed the system and bring fluid to proper level as described under "Bleeding Hydraulic System" previously in this section.

TROUBLESHOOTING THE POWER STEERING GEAR

NOISE

Several different types of noise may be heard with the control valve steering gear. Trouble shoot noises as follows:

RATTLE OR CHUCKLE

1. Cause could be loose adjustment. Make adjustment as follows:
   (a) On 553-DV type steering gears, adjust thrust bearing preload.
   (b) On 568-DV type steering gears, adjust worm bearings and sector gear lash.

2. Noise could be caused by steering gear being loose on frame.
   (a) Check steering gear installation as described earlier in this section under "Steering Gear Replacement."
   (b) Torque steering gear mounting bolts to the torque specified under "Specifications" at end of this section.

3. Coupling pin stops hitting against the upper flange could also cause this type of noise. Realignment of the shaft with the gear or an endwise adjustment of shaft should correct this condition.

NOTE: A slight rattle may occur on turns because of the increased lash off the high point. This is normal.

HISS

There is some noise in all power steering gears which cannot be eliminated. One of the most common is the "hissing" sound, most evident at standstill parking, with wheels at end of travel. The "hissing" noise is usually caused by a faulty valve.

Do not replace the valve unless the "hiss" is extremely objectionable, since the replacement valve will also have a slight "hissing" noise. Be sure, however, that the steering shaft and gear are properly aligned as the shaft rotates, since misalignment will transmit the "hissing" noise into the cab.

VALVE SQUAWK

Valve squawk when turning or when recovering from a turn may be caused by a worn dampener ring on the valve spool or by a loose or worn valve body. In both cases replace faulty parts.

STEERING GEAR LEAKS

INTERNAL LEAKS

High internal leakage will cause a momentary increase in the steering effort when turning the wheel fast. If this situation should occur, replace the control valve.

EXTERNAL LEAKS

To determine the source of external leaks, thoroughly clean the steering gear and inspect. External leakage may be due to loose hose connections or damaged hose, adjuster plug seals or torsion bar seals. Correct external leaks as follows:

CAUSE	REMEDY
1. Loose hose connections .	Tighten Connections
2. Damaged hose	Replace Hose
3. Damaged adjuster plug seals . .	Replace Seals
4. Damaged torsion bar seal . . .	Replace Seal

STEERING GEAR MALFUNCTIONS

Each of the malfunctions listed here has a number of causes and each cause has a remedy. These causes and remedies are given in "Trouble Shooting Quick Reference Chart" later.

1. Hard steering while driving.
2. Poor return of steering.
3. Leads to one side or the other.
4. Momentary increased effort on fast turn.
5. Excessive wheel kickback.
6. Steering wheel jerks.
7. Hard steering when parking.
8. Effortless turn.

POWER STEERING HYDRAULIC PUMP

NOTE: These Power Steering Hydraulic Pump fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of this part.

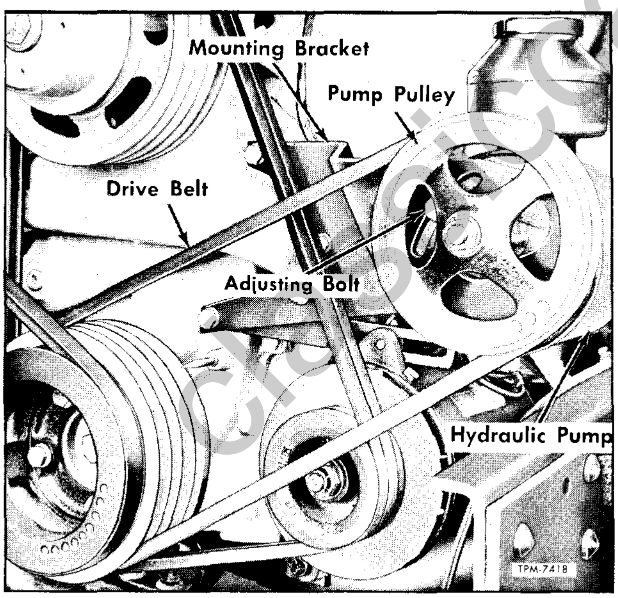


Figure 6—Power Steering Hydraulic Pump Installed (Typical)

A positive displacement vane-type or slipper-type hydraulic pump is used on vehicles covered by this manual. Refer to "Hydraulic Pump Specifications" at the end of this section for model application and capacity of each pump model.

VANE-TYPE HYDRAULIC PUMP (EXCEPT MODEL VTM-27)

The vane-type hydraulic pump is mounted at front of engine and is belt-driven from the engine crankshaft pulley in conjunction with other accessories (fig. 6).

NOTE: On models equipped with the gear-driven air compressor and generator, a vane-type hydraulic pump is gear-driven from the engine camshaft.

The oil reservoir encases the pump and on some vehicles, an additional reservoir is remotely mounted on the radiator front support or on the transmission control island support.

NOTE: On Series RM-7500, an additional reservoir is remotely mounted on a bracket attached to the air cleaner support.

On some pump models, the drive shaft is supported by a bushing in the pump housing. On others, the drive shaft is supported by one ball bearing and one needle bearing in the pump housing.

The pump rotary group is the heart of the pump and consists of the drive shaft, rotor, vanes, pump ring, thrust plate, and pressure plate. The flow control valve is the nerve center of the pump and includes the flow control plunger, flow control spring, and the pressure relief ball and spring. This assembly controls flow and pressure in the system.

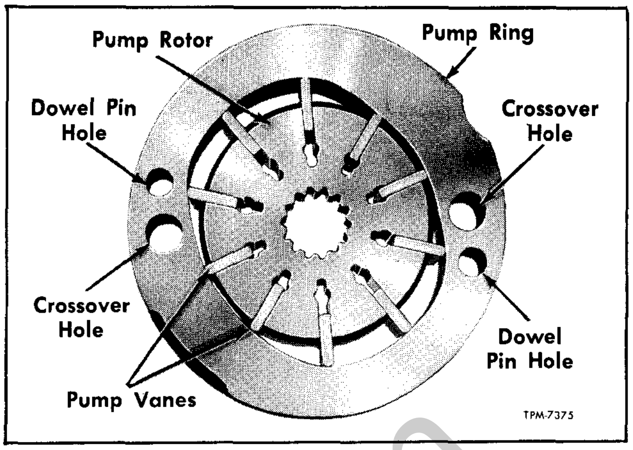


Figure 7—Cross Section of Rotor and Vanes in Pump Body

PUMP OPERATION

NOTE: Refer to figures 7 and 8.

As the drive shaft rotates the rotor, the vanes follow the cam surface in the pump ring. This cam consists of two rising and falling areas which cause a complete pumping cycle to occur every 180 degrees of rotation (fig. 7).

The spaces between rotor vanes pick up oil on the rising portions of the cam from two openings between thrust plate and pump ring and from openings between the pressure plate and pump ring. This oil is discharged on the falling portion of the cam through two openings in the pressure plate and two openings in the thrust plate which are connected to openings in the pressure plate by crossover holes in the pump ring (fig. 7). The oil passes through the pressure plate into cavity (1) behind it. A portion of this oil is directed back through other passages in the pressure plate so that it may enter behind the vanes forcing them to follow the cam surface of the pump ring (fig. 8, View B).

From cavity (1) the oil flows into passage (2) which is controlled in size to provide definitely known oil velocities. From passage (2) a certain quantity of oil passes through orifice (3) into passage (8) and then to the steering gear. Notice that passage (8) is connected to cavity (10) by passage (9). When the quantity of oil exceeds the predetermined system requirements, the pressure drop through orifice (3) exceeds force of spring (12), flow control plunger (11) starts to move back, thereby providing flow control through passages (4), (6), and (7), with (7) being the suction or intake part of the pump. Supercharging occurs as a result of pressure oil in passage (4) discharging into passage (6) at high velocity, picking up the makeup oil from reservoir through passage (5) on the jet-jump principle. Then, by a reduction of velocity in passages (6) and (7), velocity energy is converted into supercharge pressure (fig. 8, View B).

The pressure relief valve is contained inside flow control plunger (11). If pump pressure exceeds a certain predetermined pressure, the pressure relief ball will open, allowing a small amount of oil to flow through passages (8) and (9), hole (13), through flow control plunger (11) and into passage (6). This flow of oil causes a pressure drop across hole (13), thus creating a pressure unbalance which moves the flow control plunger back against spring pressure, allowing the major portion of oil to bypass through passages (2), (4), and (6) in the same manner as is accomplished by flow control (View B, fig. 8).

Figure 8, View "A" is typical of pump operation when the vehicle is driven at low speed during a partial turn. The oil pressure cannot build up high enough to cause the pressure relief valve to open as the external circuit still allows some oil to flow through the system.

Figure 8, View "B" is typical of pump operation when vehicle is driven at high speed. In this case, the flow control valve has opened to allow oil flow in excess of system requirements to bypass into intake chamber of the pump.

BELT-DRIVEN PUMP REPLACEMENT

Removal

1. Disconnect hose at pump and secure ends in raised position to prevent drainage of oil.
2. Install caps at pump fittings to prevent drainage of oil from pump.
3. Remove drive pulley attaching nut.
4. Loosen mounting bracket to pump bolts.
5. Remove pump drive belt.
6. Slide pulley from pump drive shaft. DO NOT HAMMER PULLEY OFF SHAFT AS THIS WILL DAMAGE THE PUMP.
7. Remove bracket to pump attaching bolts and remove pump.

Installation

1. Position pump assembly on mounting bracket with holes lined up and install attaching bolts loosely.

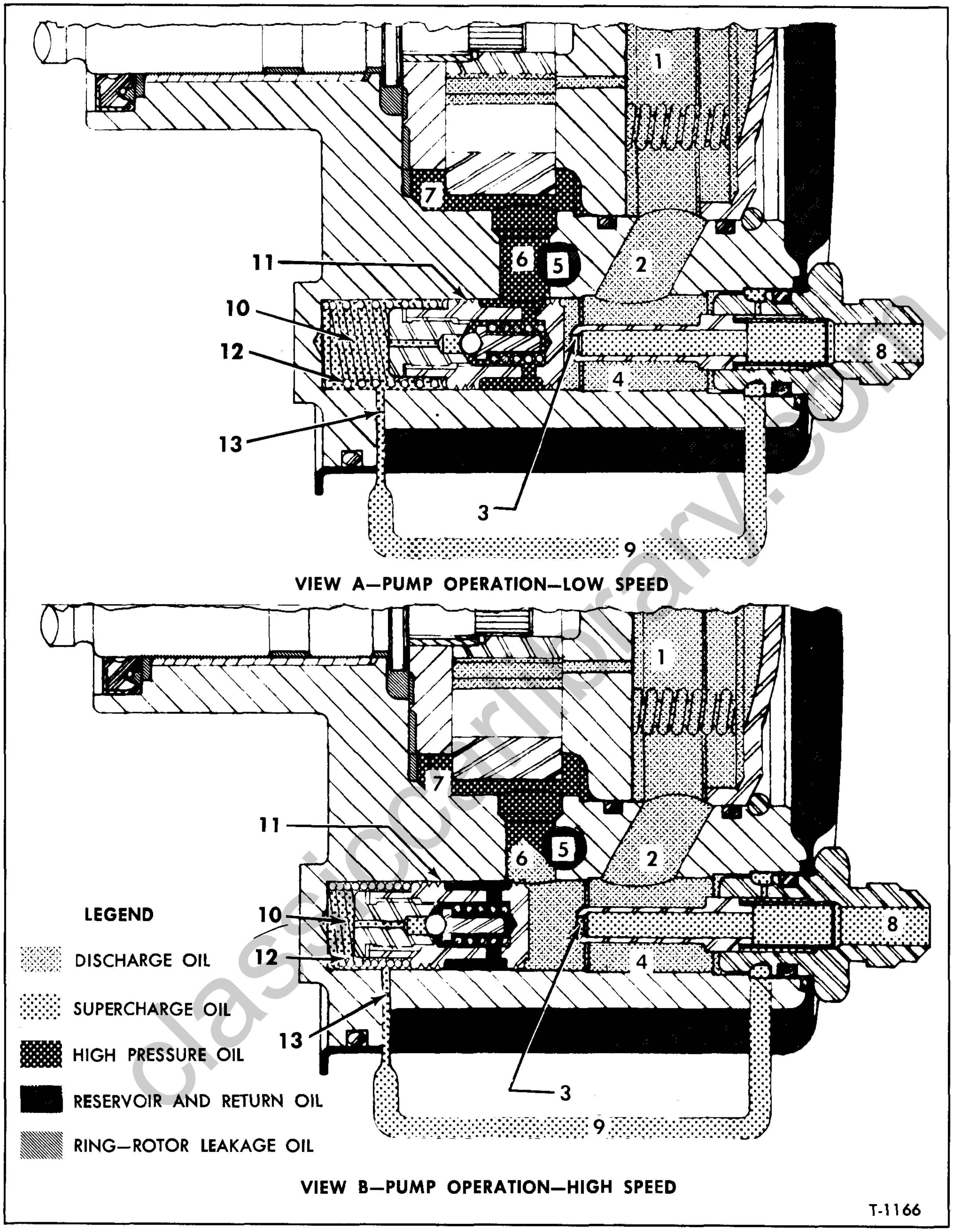


Figure 8—Power Steering Hydraulic Pump Operation

2. Slide pulley on drive shaft. DO NOT HAMMER PULLEY ON SHAFT.

3. Install pulley nut (finger-tight).

4. Connect and tighten hose fittings.

5. Fill pump reservoir with fluid recommended in LUBRICATION (SEC. 0) of this manual.

6. Bleed pump by turning pulley backward (counterclockwise as viewed from the front) until all air bubbles cease to appear.

7. Install pump drive belt over drive pulley.

8. Adjust belt tension as previously described, then tighten attaching bolts securely.

9. Tighten drive pulley attaching nut to 25 to 35 foot-pounds torque.

GEAR-DRIVEN PUMP REPLACEMENT

Removal (Fig. 9)

1. Disconnect hose at pump and secure ends in a raised position to prevent drainage of oil.

2. Install caps at pump fittings to prevent drainage of oil from pump.

3. Remove five bolts and washers which attach pump and adapter assembly to flywheel housing, then lift pump straight away from engine to complete removal.

NOTE: Drive coupling may come out with pump or it may remain on the pump drive hub.

4. Remove drive coupling from pump drive hub and remove spring from pump driven hub.

5. If pump driven hub, drive hub, or adapter are worn or damaged, remove as follows:

a. To remove the pump driven hub, remove nut and washer attaching driven hub to pump, then using a suitable puller, remove driven hub from pump shaft.

b. To separate the adapter from the pump assembly, bend bolt lock down, then remove three bolts and separate pump and adapter.

c. Remove four bolts and washers, then pull drive hub from engine camshaft gear.

Installation (Fig. 9)

1. If the pump driven hub, drive hub, or adapter were removed, install as follows:

a. Place key in pump drive shaft slot, then press pump driven hub onto pump shaft and secure with nut and washer. Tighten nut firmly.

b. Position adapter on pump assembly and secure with three bolts and locks. Tighten bolts firmly, then bend lock to secure bolt.

c. Position pump drive hub on engine camshaft gear and retainer, then attach with four bolts and washers. Tighten bolts firmly.

2. Install spring and coupling in pump driven hub.

3. Position new gasket on flywheel housing opening, then position pump and adapter assembly to flywheel housing opening making sure pump driven hub aligns properly with drive coupling. Install adapter to flywheel housing bolts and tighten firmly.

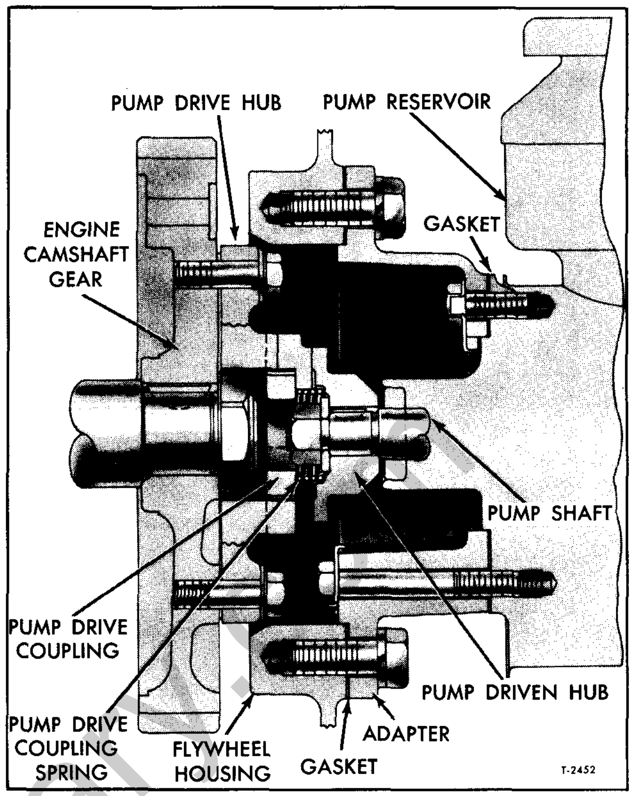


Figure 9—Gear Driven Pump Drive

4. Connect and tighten hose fittings.

5. Fill pump reservoir with fluid recommended in LUBRICATION (SEC. 0) of this manual.

6. Bleed the pump as explained previously under "Bleeding Hydraulic System."

VANE-TYPE HYDRAULIC PUMP (MODEL VTM-27)

The vane-type hydraulic pump shown in figure 10 is used on models equipped with the 8V-71 Diesel engine. The pump is belt-driven from the engine camshaft pulley. The fluid reservoir is remotely mounted and is connected to the hydraulic system by hoses.

PUMP OPERATION

Principle components of the pump include the pressure plate, pump ring, rotor, vanes, and a wear plate (fig. 10). The rotor is driven within the pump ring by a drive shaft. As rotor speed increased, centrifugal action causes the vanes to follow the cam-shaped contour of the pump ring (fig. 11). System pressure, fed behind the vanes, assures sealing contact of vanes on cam contour of the pump ring during normal operation.

1 Pump Cover Assembly
2 Control Valve Spring
3 Control Valve Assembly
4 Control Valve O-ring
5 Control Valve Plug
6 Valve Retainer Pin
7 O-ring
8 Pump Body
9 Oil Seal
10 Key
11 Pump Shaft
12 Shaft Bearing
13 Snap Ring
14 O-ring
15 Pump Rotor
16 Rotor Vane (10 Required)
17 Pump Ring
18 Pressure Plate
19 Pressure Plate Spring
20 Pump Cover Cap Screws

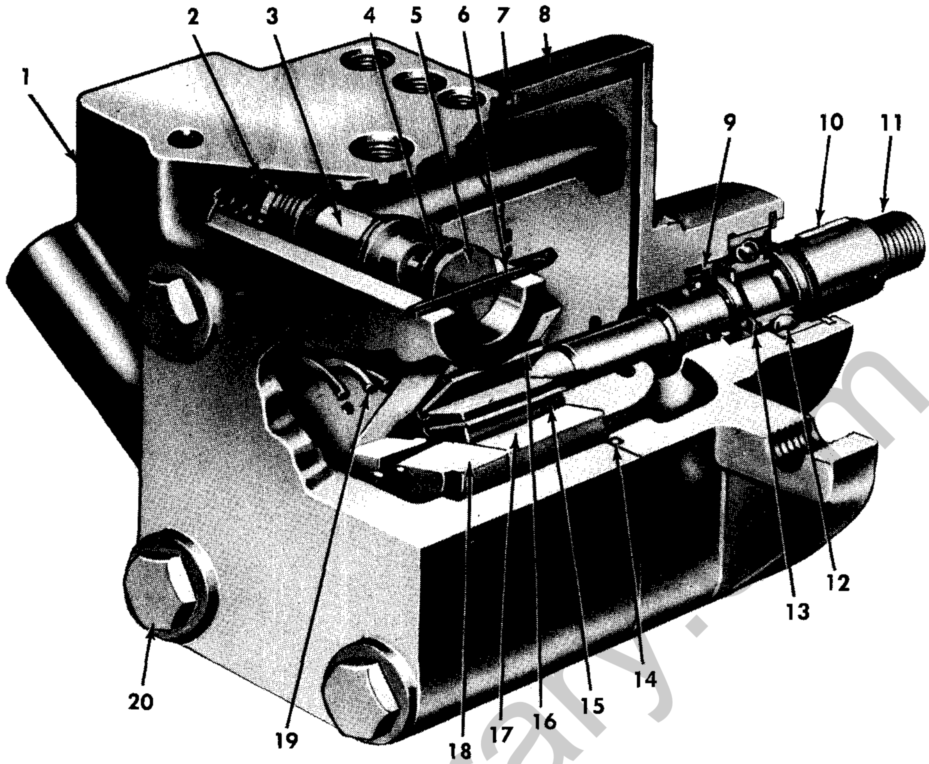


Figure 10—Cross Section of Vane Type Pump (Model VTM-27) (Typical)

The pump ring is shaped so that two opposing pumping chambers are formed, thus cancelling any hydraulic loads on the bearings. Radial movement of the vanes, and rotation of the rotor, causes the chamber area between vanes to increase in size at the inlet (large diameter) section of the ring. This results in a low pressure, or vacuum in the chamber. This pressure differential causes oil to flow into the inlet, where it is trapped between the rotating vanes and is forced, through porting in the pressure plate to discharge into the system as the chamber size decreases at the pressure quadrant (small diameter) of the ring.

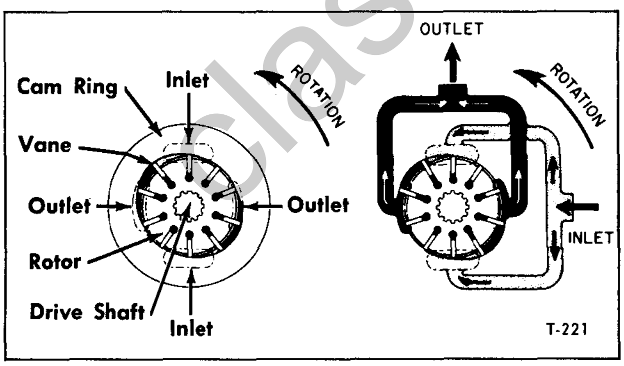


Figure 11—Pump Operation and Fluid Flow

FLOW CONTROL AND RELIEF VALVE

An integral flow control and relief valve within the pump operates on a pressure differential to limit maximum pressure within the hydraulic circuit.

Maximum pump delivery and maximum system pressure are determined by the integral flow control and relief valve in the outlet cover (fig. 12). An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to reservoir, thus limiting system pressure to a prescribed maximum.

When system pressure is equalized as shown in figure 12, View A, total pump output can be passed through the orifice to the power cylinder. This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure in this chamber equalizes pressure at the other end of the relief valve spool and the light spring holds the spool closed. Pump delivery is blocked from the reservoir port by the spool land.

When pump delivery exceeds the flow rate, determined by the orifice plug, a pressure build-up forces the spool open against the light spring.

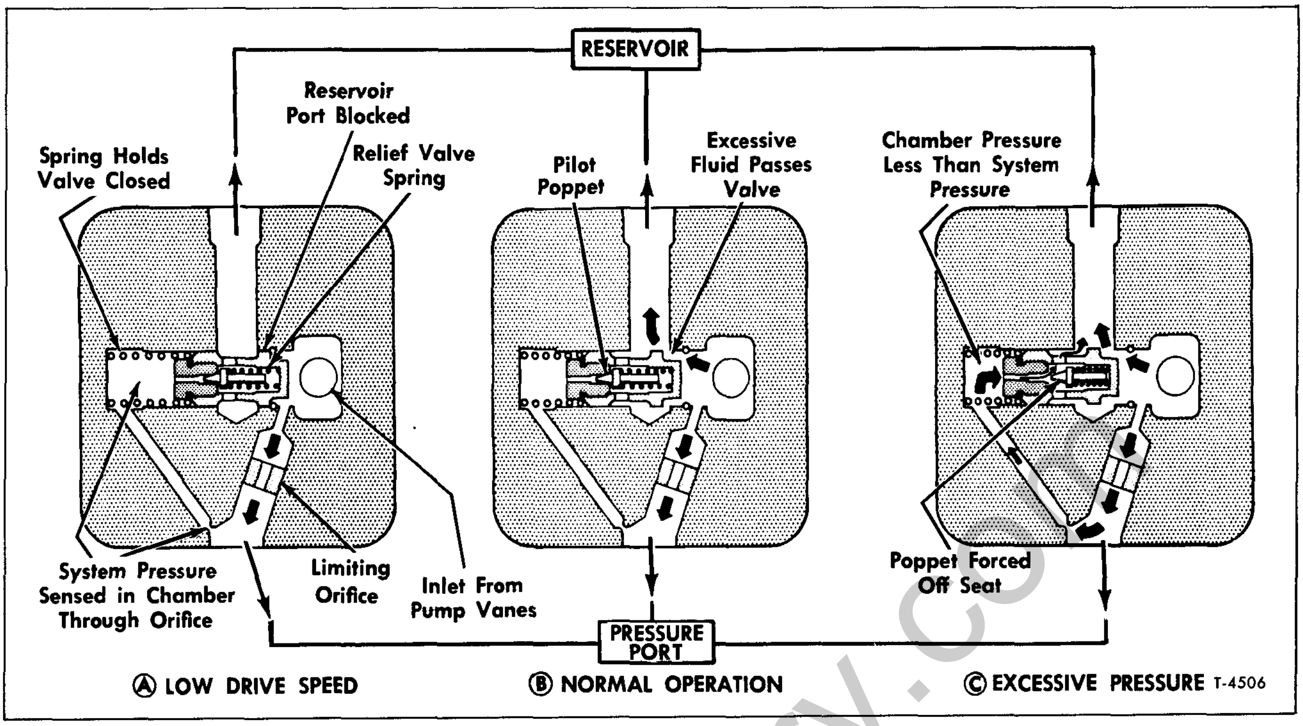


Figure 12—Hydraulic Pump Flow Control and Relief Valve Operation

Excess fluid is throttled past the spool to the reservoir port as shown in figure 12, View B.

If system pressure builds up to the relief valve setting (fig. 12, View C), the pilot poppet is forced off its seal. Fluid in the large spring chamber flows through the spool to the reservoir. This flow causes a pressure differential on the spool, shifting it against the light spring. All pump delivery is thus permitted to flow to the reservoir.

OPERATING INSTRUCTIONS

Normally, the pump does not require manual priming. However, it is essential that, after starting, a minimum drive speed of 600 rpm be held until the pump picks up its prime and pressure is built up in the system. Failure to observe the above precaution can result in scoring and possible seizure of the pump due to a lack of oil for lubrication.

NOTE: For diagnosis and remedy of trouble relative to the power steering hydraulic pump refer to "Troubleshooting The Hydraulic Pump."

HYDRAULIC PUMP REPLACEMENT

Removal

1. Disconnect hose at pump and secure ends in raised position to prevent drainage of oil from pump.
2. Install caps at pump fittings to prevent drainage of oil from pump.
3. Remove drive pulley attaching nut.
4. Loosen mounting bracket-to-pump attaching bolts; then remove pump drive belt.
5. Slide pulley from pump drive shaft. DO NOT HAMMER PULLEY OFF SHAFT AS THIS WILL DAMAGE THE PUMP.
6. Remove pump to mounting bracket bolts and remove the pump.

Installation

1. Position pump assembly on mounting bracket with holes aligned and install attaching bolts loosely.
2. Slide pulley on drive shaft. DO NOT HAMMER PULLEY ON SHAFT.
3. Install pulley nut (finger-tight).
4. Connect and tighten hose fittings.
5. Fill pump reservoir with fluid recommended in LUBRICATION (SEC. 0) of this manual.
6. Bleed the pump by turning pulley backward (clockwise as viewed from the front) until all air bubbles cease to appear.
7. Install pump drive belt over drive pulley.
8. Adjust belt tension as described previously, then tighten attaching bolts securely.
9. Final tighten drive pulley attaching nut to 25 to 35 foot-pounds torque.

SLIPPER TYPE HYDRAULIC PUMP

The slipper-type hydraulic pump is a constant displacement type pump with a minimum output of

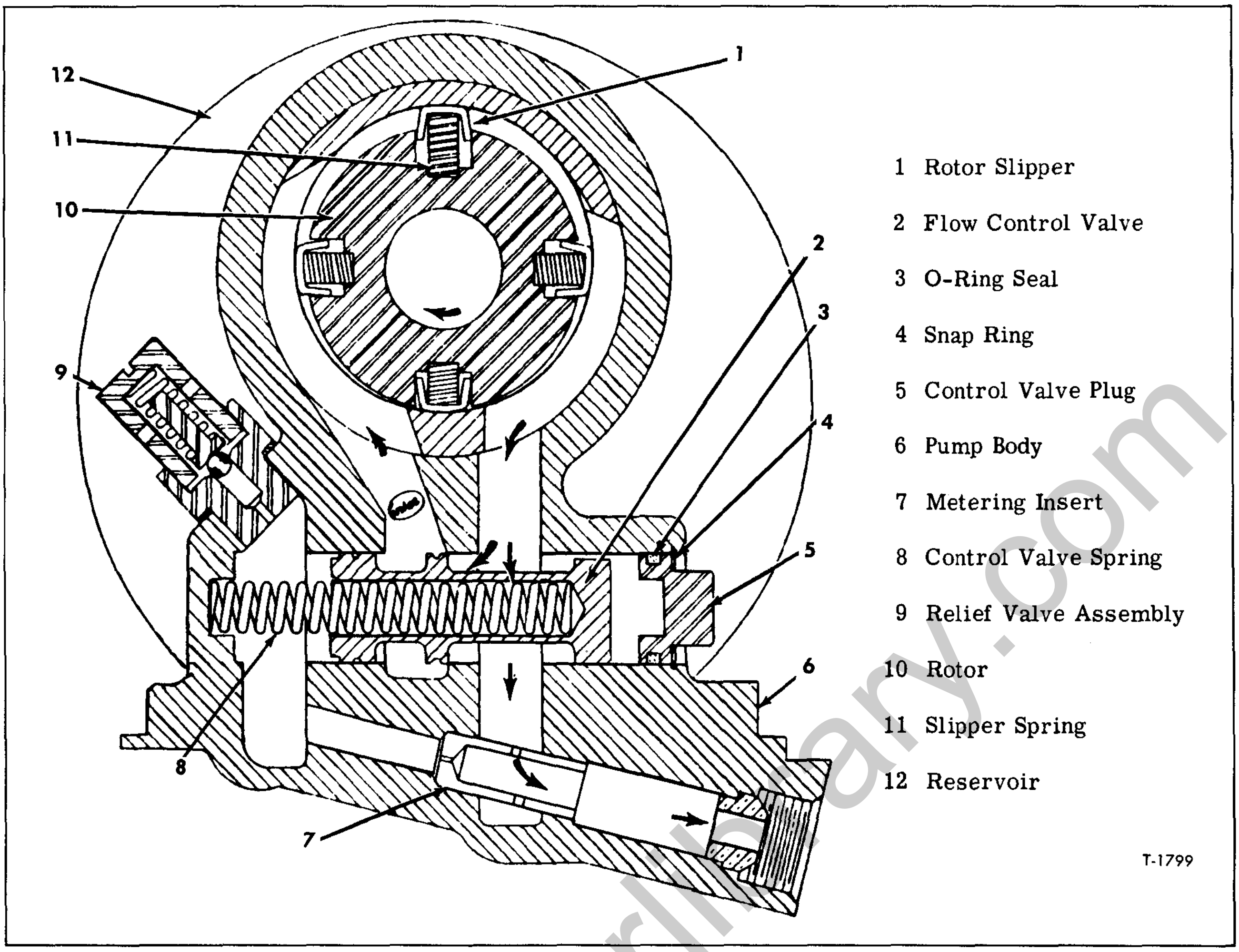


Figure 13—Slipper Type Hydraulic Pump

1.45 gallons per minute with pump idling at a speed of 450 rpm against 665 to 735 psi pressure. The pump has a maximum flow control range of 3.4 to 4.1 gallons per minute with a 1000 to 1100 psi pressure relief valve. The pump is mounted at front of engine and is belt-driven from the crankshaft.

PUMP OPERATION

As the drive shaft rotates the rotor, spring-loaded slippers, which contact the eccentric diameter inside the pump housing, force oil from the inlet side of the pump to the flow control valve (fig. 13). Pressure inside the pump is controlled by a valve which permits fluid to be recirculated within the pump. Maximum pressure in the system is limited by a pressure relief valve which opens into the reservoir when pressure exceeds specified maximum of 1000 to 1100 psi.

NOTE: At regular intervals, the fluid level in the reservoir should be checked and fluid added when level is more than two inches below filler cap. Refer to LUBRICATION (SEC. 0) of this manual, for type of fluid to be used.

IMPORTANT: Before checking fluid level, start the engine and turn steering wheel to the left and right several times to expel air from system, then shut off the engine.

PUMP REPLACEMENT

Removal

1. Loosen two cap screws which attach pump mounting bracket to engine; then move pump inward and remove drive belt.
2. Disconnect hoses at pump. When hoses are disconnected, secure ends in raised position to prevent drainage of oil. Install caps at pump fittings to prevent loss of fluid from pump.
3. Remove two cap screws and lock washers which attach pump and mounting bracket to engine.

Installation

1. Position pump and mounting bracket on en-

gine and attach with two cap screws and washers.

2. Install drive belt and adjust as previously described under "Pump Drive Belt."

3. Connect and tighten hose fittings.

4. Fill pump reservoir with fluid recommended in LUBRICATION (SEC. 0) of this manual.

5. Start engine and run for several minutes at idle speed. Turn wheels from right to left several times to expel all air from system. Recheck fluid level in reservoir and fill to proper level.

TROUBLESHOOTING THE HYDRAULIC PUMP (EXCEPT MODEL VTM-27)

PUMP NOISE

The power steering pump is not completely noiseless. Some noise will be present whenever the wheels are against the wheel stops. The noise usually becomes greater as engine speed is increased as when making a full cramped U-turn. The noise is caused by the relief valve and is normal. Momentary aeration of the oil is sometimes noticeable under these conditions. Some noise may also be present under standstill parking condition, particularly when the wheel stops are contacted. Power steering pump noise can be confused with many other things such as transmission, rear axle, generator, etc. If it is is determined that excessive noise is present, remove the pump drive belt to make sure the pump is at fault. If it is determined that the pump is at fault, proceed as follows:

1. Check Drive Belt Tightness. Adjust belt tension, if necessary, as described previously under "Pump Drive Belt."

2. Check Oil Level. Refill, if necessary, as described in LUBRICATION (SEC. 0) of this manual.

3. Check Hose. Make sure hose is not touching any other parts of the vehicle, especially the sheet metal.

4. Check for Presence of Air in The Oil. Air will show up as bubbles or oil will appear milky. Small amounts of air cause extremely noisy operation. If air is present in oil accomplish the following:

a. Tighten all fittings and bolts.

b. Check the entire system for source of air leak. Air can leak into the system at any place. Air leaks usually occur at joints in the system where oil passes through at high velocity - such as hose connections or at the drive shaft seal.

NOTE: After each step in attempting to eliminate air, the pump should be operated for a few minutes at idle speed while occasionally turning the steering wheel between extreme turns to allow air to bleed out of oil.

5. After Eliminating Air From The Oil. Install a pressure gauge in the pressure line between the pump and steering gear. If, when racing the engine to about 1000 rpm and without turning the wheels, pressure exceeds 125 psi, the hose and/or the steering gear are restricting the oil flow. These parts should be examined to determine cause of restriction.

6. If The Pressure is Less Than 125 Psi in Step 5 Above, remove the pump and repair.

PUMP LEAKS

Whenever oil leakage occurs in the hydraulic pump, all fittings and bolts should be cleaned and tightened. If this does not stop leakage, wipe pump assembly clean to determine where it is leaking. Following are some of the possible causes of pump leakage: (See table below.)

SOURCE OF LEAK	CAUSE	REMEDY
Top of reservoir	Reservoir too full.	Fill to proper level.
	Air in the oil.	Eliminate air as previously described under "Pump Noise."
At the pressure fitting or studs	Not tightened sufficiently.	Torque to 25-40 foot-pounds.
	Cross threaded or defective seat on fittings or hose end. Damaged seals.	Correct as necessary.
At shaft seal	Defective seal or damaged shaft.	Replace damaged parts.
Leaks in metal parts.	Damaged castings.	Replace damaged parts.

POOR, OR NO ASSIST, OR PUMP INOPERATIVE

When the pump is inoperative, providing little or no assist in turning, first check the belt tension and adjust it as necessary, as previously described under "Pump Drive Belt." If this does not correct the problem, check the oil level, fill and bleed the system as described previously.

If there is no improvement, it must be established whether the pump, steering gear, or hose are the source of trouble. This may be determined by two tests after placing a pressure gauge in the pressure line between pump and steering gear.

Test #1 is Performed With The Oil Circuit Open. Raise the temperature of oil to operating range of 150° to 170°F. measured with a thermometer. This may be accomplished by turning the wheels from wheel stop to wheel stop several times. Do not hold steering wheel against wheel stop for any extended period as this will overheat the oil. As previously mentioned, the pressure relief valve in the pump will not be able to handle the excessive pressure created by contacting the wheel stop for an extended period of time, therefore, the oil will overheat.

After heating the oil to at least 150°F., set engine idle to 450 rpm; then turn the steering wheel from one end to the other and read pressure on gauge while holding the wheel momentarily against the stops. The reading should be the maximum with engine idling at 450 rpm. If it is not, trouble is in the hydraulic circuit, but it does not indicate whether the pump or steering gear, or both, are at fault.

This can be determined by performing Test #2 and comparing it with Test #1.

Test #2 is Performed With the Oil Circuit Closed. Set engine idle at 450 rpm and turn the shut-off valve of gauge to the closed position.

NOTE: Shut-off valve must be located between the gauge and steering gear. Observe pump pressure on gauge at idle and compare it with Test #1.

Diagnosis of the Two Tests. If the first test is below specifications and the second test is equal to specifications, or greater, the steering gear is at fault. When the first test is below specifications and the second test is not more than 50 psi greater, the pump is at fault.

NOTE: If steering gear is found to be at fault, use the troubleshooting procedures for the steering gear described under "Troubleshooting The Power Steering Gear" previously in this section.

NOTE: For additional troubleshooting information, refer to "Quick Reference Troubleshooting Chart" later in this section.

TROUBLESHOOTING THE HYDRAULIC PUMP (MODEL VTM-27)

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING OIL	Belt slipping or broken.	Adjust belt tension or replace drive belt.
	Oil viscosity too heavy to pick up prime.	Use fluid of proper viscosity as recommended in LUBRICATION (SEC. 0) of this manual.
	Pump intake partially blocked.	Drain system completely; flush to clear pump passages, then flush and refill.
	Air vent for reservoir clogged - or dirty strainer.	Remove filler cap and clean air vent slot. Check filter or strainer in reservoir for clogged condition. Drain, flush and add clean oil to the system.
	Pump drive shaft disengaged or sheared.	Remove pump and overhaul.
	Flow control valve stuck open.	Remove pump, disassemble, and clean control valve.
	Vane or vanes stuck in rotor slots.	Remove pump, disassemble and repair.

TROUBLESHOOTING THE HYDRAULIC PUMP (MODEL VTM-27) (CONT'D.)

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOISY	Restricted or partially clogged intake line.	Drain system and flush intake line. Add new oil to system.
	Air leak at pump intake piping joints or pump shaft seal.	Test by pouring oil on joints and around drive shaft. Listen for a change in operation. Tighten joints or remove pump and disassemble to replace pump drive shaft seal.
	Reservoir or manifold seal leakage.	Leakage between manifold or reservoir at replenishing hole due to O-ring damage. The reservoir inlet tube to pump cover O-ring should be carefully examined for damage; such as cuts, nicks, or dirt. Replace O-rings if damaged.

POWER STEERING POWER CYLINDER

NOTE: These power steering power cylinder fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

There are three power cylinders covered in this section. The power cylinder acts as a power assist to the mechanical steering. Refer to "Specifications" at end of this section for power cylinder application on each series vehicle.

On conventional cab models, a side-mounted cylinder is bracketed to the frame side rail at one end and to the Pitman arm at the other end. On conventional cab models equipped with the F-160 front axle, an additional right-hand power cylinder is bracketed to the frame side rail at one end and to a right-hand idler arm at the other end.

On tilt cab models, the power cylinder is bracketed to the front axle at one end and to the steering tie rod at the other end.

Stationary metal tubes and flexible hose assemblies carry hydraulic fluid to the cylinder to operate the piston for right and left turns.

When the driver turns the steering wheel, the control valve on the steering gear housing directs hydraulic fluid, under pressure from the hydraulic pump, to either side (depending on whether a right or left turn is being made) of a piston in the power cylinder (fig. 14). This produces movement of the piston and attached steering linkage. The force applied by the power cylinder is the amount of thrust necessary for all steering requirements.

On completion of a turn, reduced effort on the steering wheel allows steering geometry of the vehicle to return front wheels to a straight-ahead position. When returning to a neutral position, oil on one side of the piston is forced back to the hydraulic pump reservoir by oil on the other side of the piston, equalizing the oil pressure. This constant amount of oil in the cylinder acts as a shock absorber to dissipate road shock to the operator.

NOTE: The same procedure applies to some vehicles equipped with the F-160 front axle, except that hydraulic fluid, under pressure from the hydraulic pump, is directed through a junction block to either side of a piston in the right and left power cylinders. This causes one cylinder piston and attached steering linkage to extend and the other to retract (depending on whether a right or left turn is being made).

The power cylinders used on these vehicles are of the same basic design for all models. The only difference is in the stroke length which for all models is dependent upon the axle capacity. On conventional cab models, the power cylinder piston rod is threaded directly onto the piston.

POWER CYLINDER REPLACEMENT

REMOVAL

1. Clean dirt from around hose connections at the power cylinder.

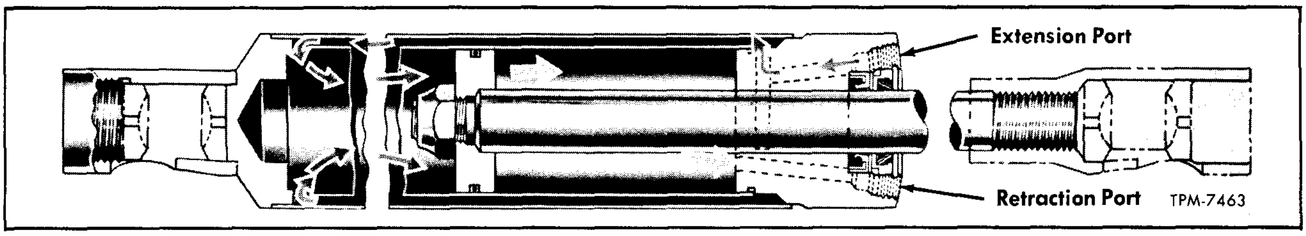


Figure 14—Power Cylinder Oil Flow (Typical)

2. Disconnect hoses from power cylinder, catching hydraulic fluid in a suitable clean container. Cover hose fittings and ports in cylinder.

3. Remove cotter pin and loosen adjuster screw securing end of the power cylinder to support bracket mounting ball enough that the cylinder can be removed from the mounting ball.

4. Repeat procedures in Step 3 above and remove the opposite end of power cylinder from tie rod or Pitman arm ball stud.

INSTALLATION

1. Position power cylinder on tie rod or Pitman arm ball stud and to support bracket mounting ball.

2. Turn adjuster screw at each end of the power cylinder in tight; then back off to nearest cotter pin holes and install new cotter pins.

3. Turn front wheels from extreme right to left and check to see that the power cylinder does not bottom preventing stops from hitting the axle.

4. Reconnect hydraulic hoses to power cylinder ports. Tighten fittings to 20 to 30 foot-pounds torque. NOTE: Make certain hoses are not kinked and do not bind when wheels are turned.

5. Bleed the hydraulic system and bring fluid to proper level as previously directed under "Bleeding The Hydraulic System."

POWER CYLINDER SEAL REPLACEMENT

REMOVAL (Refer to Fig. 15)

NOTE: The two power cylinders covered in the following procedures are of the same basic design. The only difference is in the stroke length, which for all models is dependent upon the axle capacity. The only parts that can be replaced in the power cylinder are the piston rod seals, socket end ball stud seats, and adjuster screws.

1. If not previously removed, remove cotter pin, adjuster screw, and ball seats from one end of the power cylinder. Use a wide blade screwdriver to turn adjuster screw out. Repeat these procedures at opposite end of the cylinder.

2. Loosen clamp bolt on the outside of the socket.

3. Using a wide blade screwdriver to keep the piston from turning, unthread socket end from piston rod.

4. Force piston rod in and out of power cylinder to drain remaining fluid.

5. Using Tru-Arc snap ring pliers, remove the scraper retainer snap ring from groove in piston rod guide assembly.

6. Apply air pressure to the retraction port

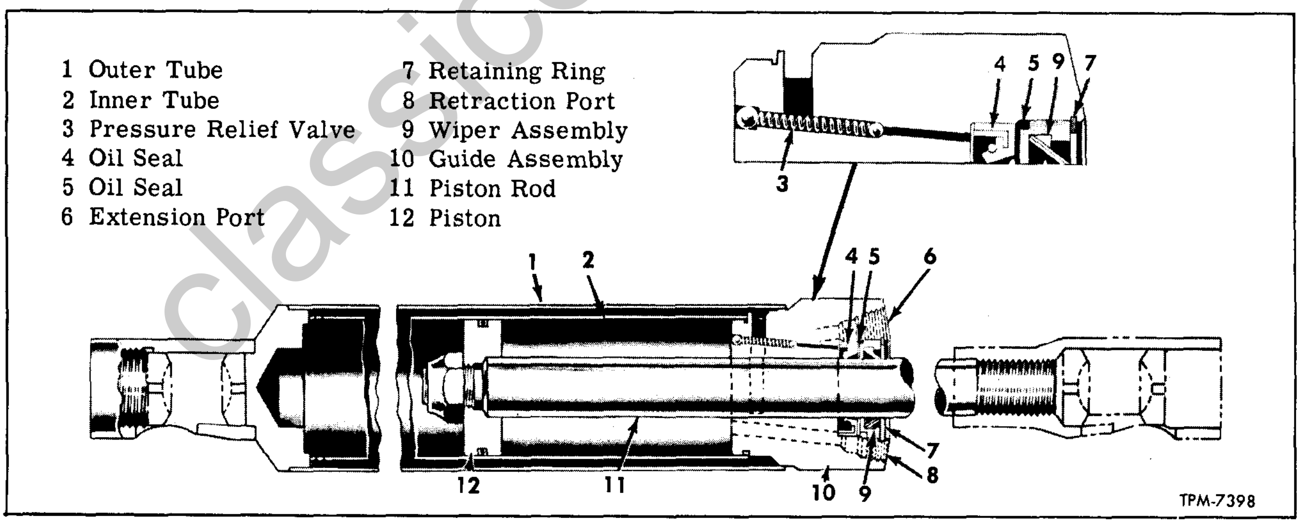


Figure 15—Power Cylinder (Typical)

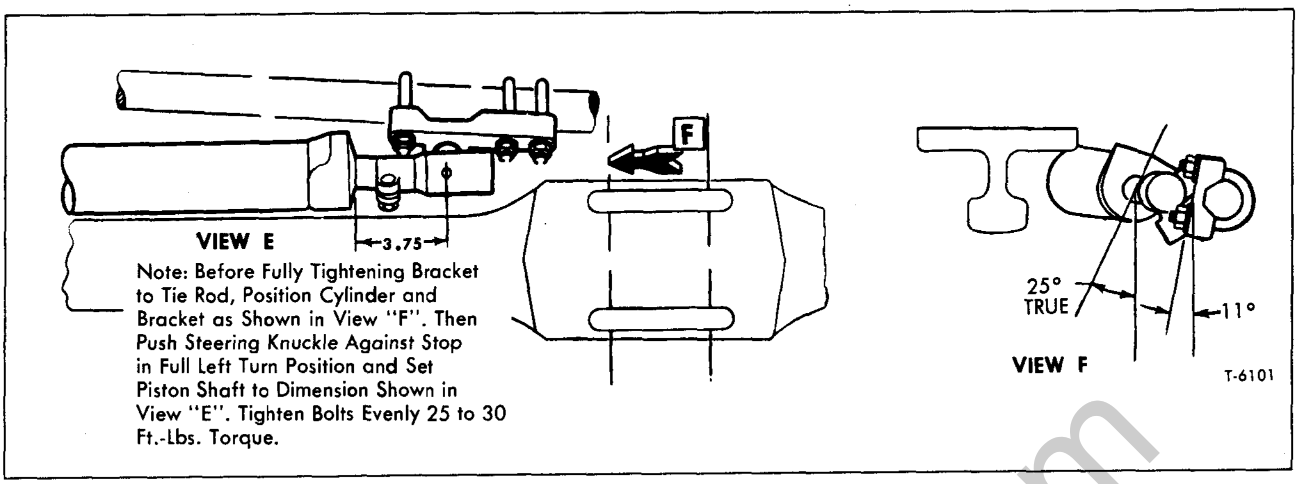


Figure 16—Axle Mounted Power Cylinder Adjustment (Typical)

in the guide assembly while at the same time holding a finger over the extension port (fig. 14). This will dislodge wiper ring assembly, scraper retainer, scraper retainer O-ring seal, and piston rod seal from the guide assembly.

CLEANING AND INSPECTION

Clean and inspect the components using cleaning solvent and compressed air. Replace all parts that are not in first class condition.

ASSEMBLY (Refer to Fig. 15)

1. Lubricate lip of the piston rod seal with a thin layer of Lubriplate or equivalent, and insert it into the guide assembly with the "U" of the cup toward the bottom of opening in guide.
2. Install scraper retainer O-ring seal.
3. Install the scraper retainer in guide with "U" side pointing out.
4. Insert the wiper ring assembly; then using Tru-Arc snap ring pliers, install the retaining snap ring. Make sure retaining ring is well seated in groove of the guide assembly.
5. Thread the socket end assembly on piston rod until it shoulders against the rod.
6. Tighten the clamp bolt securely.
7. At both ends of the power cylinder, install ball seats; then thread the adjuster screws into the sockets loosely.

POWER CYLINDER ADJUSTMENT

AXLE-MOUNTED CYLINDER

Adjustment dimensions for all axle-mounted cylinders are shown in figure 16. Before fully tightening clamp to tie rod, push steering knuckle against stop in full left turn position and set piston shaft to dimension applicable to axle being used (fig. 16).

SIDE-MOUNTED CYLINDER

No adjustment is required on side-mounted cylinders since the distance between ball stud connections is not subject to adjustment or change.

TROUBLESHOOTING THE POWER CYLINDER

POWER CYLINDER LEAKAGE

INTERNAL LEAKS

Internal leakage in the power cylinder will show up in a momentary increase in driver effort when turning the wheel fast. If this occurs, replace complete cylinder assembly.

EXTERNAL LEAKS

If the power cylinder is leaking externally, wipe it clean to determine where it is leaking. Leakage around the piston rod seals may be corrected by replacing the seals. If the power cylinder still leaks after replacing the seals, the pressure relief valve is not operating properly and the complete power cylinder will have to be replaced. Any leakage around the welds on the cylinder will necessitate replacing the complete power cylinder assembly. Tighten the hose connections at the extension and retraction ports if this is a source of leakage. If tightening the connection does not stop leakage, replace complete cylinder assembly.

NOTE: Any damage to the cylinder which will hamper its operation necessitates replacement of the complete power cylinder assembly. The cylinder is not serviced except for the piston rod seals.

NOTE: For additional troubleshooting information, refer to "Quick Reference Troubleshooting Chart" at end of this section.

TIE ROD ANTI-ROTATION BUSHING

> NOTE: These tie rod anti-rotation bushing fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

On some trucks covered in this manual equipped with power steering, anti-rotation bushings are installed over tie rod end studs between tie rod ends and steering arms (fig. 17). Each bushing consists of two cupped washers and a rubber washer. Purpose of anti-rotation bushings is to prevent weight of the power cylinder, which is clamped to the tie rod, from rotating the tie rod and causing tie rod ends to bind against the ball studs. Bushings should be replaced if they become worn enough to permit rotation of the tie rod.

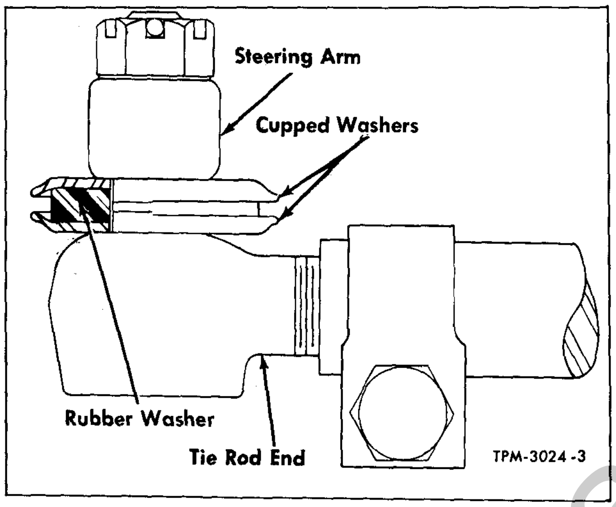


Figure 17—Tie Rod Anti-Rotation Bushing

BUSHING REPLACEMENT

REMOVAL

1. At each end of the tie rod, remove cotter pin and stud nut. Discard cotter pins.
2. Tap tie rod loose from steering arms.
3. Remove two cupped metal washers and rubber washer from each tie rod end stud. Discard these parts.

INSTALLATION

1. Position two new cupped washers and new rubber washer on each tie rod end stud.
2. Loosen both socket end clamp bolts; then install tie rod on steering arms, rotating socket ends as necessary to align parts. The upper and lower cupped washers must be parallel when no power or pressure is applied to the tie rod. Install stud nuts and new cotter pins.
3. With parts properly aligned (fig. 17), tighten socket end clamp bolts to 40-50 ft.-lbs. torque.
4. Install tie rod ball studs to steering arms and torque to "Specifications" listed at the end of this section.

OIL COOLER

An oil cooler is attached to the radiator front support on some gasoline engine models with power steering. The oil cooler is not used on Diesel engine models with power steering.

The cooler may be removed for repair or replacement, if necessary, by disconnecting hoses and removing screws which attach it to support braces.

OIL COOLER MAINTENANCE

At regular intervals, or when operating conditions warrant, examine the cooler for leaks and bent fins. A damaged or leaking cooler should be serviced by a radiator specialist or replaced with a new assembly. Proper repair requires the use of special tools and equipment as well as provisions for making proper tests.

If the cooler assembly requires painting, spray with special radiator paint; do not use paint mixed with oil, as oil mixed paint will form an insulation and prevent efficient dissipation of heat.

Occasional external flushing with water, using an ordinary hose, will help remove dirt, bugs, and other foreign matter from between fins of cooler. Water under pressure should be directed from behind the cooler to force dirt out in opposite direction of its entrance. Direct the water stream against edges of fins (not sideways) to eliminate danger of bending fins.

QUICK REFERENCE TROUBLE SHOOTING CHART

NOTE: Some of the remedial procedures suggested for conditions outlined in this chart constitute overhaul of components which is not within the scope of this manual.

HYDRAULIC PUMP

CONDITION	CAUSE	REMEDY
1. Pump Noise.	Loose belt.	Tighten belt.
	Hoses touching other parts of truck.	Adjust hose position.
	Low oil level.	Fill reservoir.
	Air in the oil.	Locate source of air leak and correct.
	Excessive back pressure caused by hoses or steering gear.	Locate restriction and correct. Bleed system.
	Scored pressure plate.	Lap away light scoring. Replace heavily scored part.
	Vanes not installed properly.	Install properly.
	Extreme wear of pump ring.	Replace ring.
	Vanes sticking in rotor slots.	Free up by removing burrs or dirt.
	Face of thrust plate scored.	Lap away light scoring. Replace heavily scored part.
	Scored rotor.	Lap away light scoring. Replace heavily scored part.
	Defective flow control plunger.	Replace assembly.
2. Leaks at top of of reservoir.	Reservoir too full.	Fill to proper level.
	Air in the oil.	Locate source of air leak and correct.
3. Leaks at the reservoir.	O-Ring seal cut.	Replace O-Ring seal.
	O-Ring improperly installed.	Install seal properly.
4. Leaks at the pressure fitting or mounting stud.	Not tightened sufficiently.	Torque to 30-40 ft.-lbs.
	Cross threaded or damaged seat.	Replace damaged part.
	Defective seat on hose end.	Replace hose.
	Damaged seals.	Replace seals.
5. Leaks at the shaft seal.	Defective seal.	Replace seal.
	Damaged shaft.	Replace shaft.
6. Leaks in metal parts.	Poor casting.	Replace defective parts.
7. Pump inoperative, poor, or no assist.	Loose drive belt.	Tighten belt.
	Low oil level.	Fill reservoir to proper level.
	Air in the oil.	Locate source of air leak and correct.
	Defective hoses or steering gear as determined by test outlined under gear section later in this chart.	Correct.
	Flow control valve stuck.	Remove burrs or dirt.
	Loose nut in end of flow control valve.	Tighten nut.
	Pressure plate not flat against ring.	Correct condition.
	Extreme wear of pump ring.	Replace pump ring.
	Scored pressure plate, thrust plate, and/or rotor.	Lap away light scoring. Replace heavily scored parts.

8. **Pump inoperative, poor, or no assist.**	Vanes not installed properly. Vanes sticking in rotor slots. Faulty flow control valve assembly.	Install vanes properly. Free up by removing burrs or dirt. Replace assembly.

CONTROL VALVE AND POWER STEERING GEAR

CONDITION	CAUSE	REMEDY
1. **Gear noise (rattle or chuckle).**	Loose over-center adjustment. Coupling pin stops, hitting against upper flange. **NOTE:** A slight rattle may occur on turns because of the increased lash off the high point. This is normal. Gear loose on frame.	Adjust to specification. Re-align shaft with gear. Adjust endwise if necessary. Check gear to frame mounting bolts. Tighten bolts to specifications.
2. **Gear noise (hissing sound).**	There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking.	Do not replace valve unless "hiss" is extremely objectionable. Be sure steering shaft and gear are aligned so the flexible coupling is not distorted as shaft rotates. Any metal to metal contact through the flexible coupling will transmit the valve hiss into the truck.
3. **Valve squawk when turning or when recovering from a turn.**	Cut or worn dampener O-Ring on spool Loose or worn valve.	Replace dampener O-Ring, being careful not to cut the new ring at installation. Replace valve.
4. **Internal leaks.**	Momentary increased effort on fast turn.	Replace valve.
5. **External oil leaks (wipe gear thoroughly and make sure source of leakage is determined).**	Loose hose connections. Damaged hose. Adjuster plug seals Torsion bar seal	Tighten. Replace. Replace seal. Replace torsion bar and stub shaft assembly.
6. **Hard steering while driving.**	Frozen steering shaft bearings. Lower coupling flange rubbing against adjuster. Steering wheel rubbing against gearshift bowl. Steering adjustment tight.	Replace bearings. Loosen bolt and assemble properly. Adjust jacket endwise. Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary.
7. **Poor return of steering.**	Frozen steering shaft bearings. Lower coupling flange rubbing against adjuster. Steering wheel rubbing against gearshift bowl. Tires not properly inflated. Incorrect caster or toe-in front wheels. Tight steering linkage. Steering gear misalignment. Tightness of suspension joints. Steering adjustment tight. Tight sector to ball nut adjustment. Thrust bearing adjustment too tight. Sticky valve spool.	Replace bearings. Loosen bolt and assemble properly. Adjust jacket endwise. Inflate to specification. Adjust as described in front axle (Sec. 3) of this manual. Lubricate linkage as described in lubrication (Sec. 0) of this manual. Re-shim at frame. Lubricate or otherwise free up. Check adjustment by dropping pitman arm from gear or disconnecting linkage from pitman arm ball. Readjust if necessary. Adjust in truck to specification. Remove gear and adjust to specifications. Remove and clean valve or replace valve.

8. Truck leads to one side or to the other.	Due to front end misalignment. Unbalanced or badly worn valve. **NOTE:** If this is the cause, steering effort will be very light in direction of lead and heavy in opposite direction.	Adjust to specification. Replace valve.
9. Momentary increase in effort when turning wheel fast.	Low oil level in pump. Pump belt slipping.	Check oil level in pump reservoir and bring to proper level. Tighten or replace belt.
10. Excessive wheel kick-back or loose steering.	Lash in steering linkage. Air in the system. Excessive lash between pitman shaft sector and ball nut. Loose thrust bearing adjustment.	Adjust parts affected. Add oil to pump reservoir. Adjust to specification. Remove steering gear and adjust to specification.
11. Steering wheel surges or jerks when turning with engine running—especially during parking.	Loose pump belt.	Adjust to specification.
12. Hard steering when parking.	Loose pump belt. Low oil level in reservoir. Lack of lubrication in linkage for front suspension. Tires not properly inflated. Insufficient oil pressure.	Adjust to specification. Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Add lubricant where needed as described in lubrication (Sec. 0) of this manual. Inflate to recommended pressure. If all of the above checks do not reveal the cause of hard steering, make the following tests of oil pressure: a. Disconnect the pressure line at oil pump. Attach gauge to pump. Connect the hose to end of gauge where the valve is located. b. With the engine at warm idle and gauge valve open, note the oil pressure on the gauge while turning steering wheel from one extreme position to the other. Especially note the maximum pressure which can be built up with the wheel held in either right or left extreme position. **CAUTION:** Do not hold wheel in extreme position for an extended period of time because it will drastically increase the oil temperature and will cause undue wear on the oil pump. c. With oil temperature between 150 degrees F and 170 degrees F, as measured with a thermometer in the reservoir, the maximum oil pressure should not be less than 600 PSI for satisfactory power steering operation. d. If the maximum oil pressure is less than 600 PSI, it indicates trouble in the pump, steering gear, cylinder, or a combination of these parts. To eliminate the gear, close the gauge valve and quickly test pressure of the pump only with the engine at warm idle; then open the valve to avoid increasing oil temperature.

Hard steering when parking. (Cont'd)		Comparing the maximum pressures obtained in these two tests will indicate source of trouble as follows: (a) First test pressure low and second test pressure normal—indicates faulty external oil lines, or steering gear. (b) First test and second test pressures equally low—indicates faulty oil pump. If the above test shows trouble to be in pump, see hydraulic pump procedures described previously. If trouble is shown to be in steering gear or hoses, examine for external oil leaks as described under LEAKS—ITEM 5.
	Low oil pressure due to restriction in hoses:	
	a. Check for kinks in hoses.	Remove kinks.
	b. Foreign object stuck in hose.	Remove hoses and remove restricting object or replace hose.
	Low oil pressure due to steering gear	
	a. Leakage at valve rings, valve body to worm seal.	Remove gear from truck for disassembly and replace seals.
	b. Loose fit of spool in valve body or leaky valve body.	Replace valve.
13. No effort required to turn.	Broken torsion bar	Replace torsion bar and stub shaft assembly.
	POWER CYLINDER	
1. Internal leaks.	Momentary increased effort when turning wheel.	Replace cylinder assembly.
2. External leaks.	Around piston rod seals. At hose connections. Around welded joints.	1. Replace seals. 2. Cylinder relief valve not working—replace cylinder assembly. Tighten or replace cylinder if tightening does not remedy condition. Replace cylinder assembly.
3. Excessive ball socket movement.	End play present. Worn ball seats.	Adjust to specifications. Replace seats.
4. Piston rod end clamp movement.	Loose bolts.	Torque to specifications after proper positioning to specifications.

SPECIFICATIONS

POWER STEERING GEAR APPLICATION CHART

TRUCK SERIES	GEAR MODEL	RATIO
HV/JV-70, HM/JM-80		
HI/HN/JI/JN/MH/MI-90	553-DV-82	28.14 to 1
TV-70/TM-80	553-DV-54	28.14 to 1
FC/FH/FI/FN/DC/DH/DI/DN-90	554-DV-5	28.14 to 1
*Conventional Cab Models with F-160 Front Axle	553-DV-86	28.14 to 1

POWER STEERING HYDRAULIC PUMP MODEL APPLICATION CHART

TRUCK SERIES	PUMP MODEL	TYPE PUMP
HV-JV-70	235-P-36	Vane
HM/JM/TM-80	235-P-125	Vane
TV/70	235-P-19	Vane
HI/JI-90	235-P-46	Vane
HN/JN-90	235-P-44	Vane
MH-90/FH/DH-90	VTM-27-50-30-10-MJ-LI-12	Vane
MI-90/FI/DI-90	235-P-132	Vane
DN/FN/DC/FC-90	235-P-43	Vane
JN-90 with F-160 Front Axle	235-P-47	Vane

HYDRAULIC PUMP SPECIFICATIONS

VANE TYPE PUMP (SAGINAW GEAR)

Make ..... Saginaw Steering Gear Division
Minimym Capacity Per Minute ... 2.35 G.P.M. of Automatic Transmission Fluid at 170°F. When Operating Pump at Idle Speed Against 665/735 P.S.I.
Maximum Capacity Per Minute—
- Except 235-P-124, 235-P-43 and 235-P-47 ..... 3.5 G.P.M. of Automatic Transmission Fluid at 170°F. When Operating Pump at 1500 RPM Against 50 P.S.I. Pressure.

Pump Model 235-P-43, 235-P-47 and
- 235-P-124 ..... 4.8 to 5.2 G.P.M. of Automatic Transmission Fluid at 170°F. When Operating Pump at 1500 R.P.M. Against 50 P.S.I. Pressure.

Pressure Relief Valve
- Except 235-P-43; 235-P-47 and 235-P-124
  - Minimum P.S.I. 900
  - Maximum P.S.I. 1000

Pump Models 235-P-43, 235-P-47 and 235-P-124
- Minimum P.S.I. 1100
- Maximum P.S.I. 1200

VANE TYPE PUMP (VICKERS)

Make ..... Vickers Corporation
Maximum Capacity
- Model VTM-27-50-30-10-MJ-LI-12 ..... 3.0 G.P.M.

Pressure Relief Valve ..... 1000 P.S.I.

SLIPPER TYPE PUMP (THOMPSON)

Make ..... Thompson Products
Capacity Per Minute
- Maximum ..... 3.4 to 4.1 G.P.M.
- Minimum ..... 1.45 G.P.M. with Pump Operating at Idle Speed Against 665/735 P.S.I.

Pressure Relief Valve
- Minimum P.S.I. 1000
- Maximum P.S.I. 1100

SPECIFICATIONS (CONT.)

POWER STEERING POWER CYLINDER				
TRUCK SERIES	TYPE OF MOUNTING	RETRACTED LENGTH	EXTENDED LENGTH	STROKE
Conventional Cab Models with F-070; F-090; F-120; F-160 Front Axle	Side	16.680"	25.740"	$9\frac{1}{16}$"
Series T-70, 80				
With F-070 Front Axle	Axle	16.680"	25.740"	$9\frac{1}{16}$"
F-090; F-120 Front Axle	Axle	19.806"	30.866"	$11\frac{1}{16}$"
Series T-70, 80				
With F-090 Front Axle	Axle	17.936"	26.996"	$9\frac{1}{16}$"
F-120, F-160 Front Axle	Axle	19.806"	30.866"	$11\frac{1}{16}$"

POWER STEERING TORQUE SPECIFICATIONS

LOCATION	TYPE OF PART	TORQUE (FT.-LBS.)
Steering Gear to Frame Bolt		
Conventional Cab Models	Nut	50-60
Steel Tilt Cab Models	Nut	90-110
Pitman Arm to Shaft		
Conventional Cab Models-Pinch Bolt	Nut	100-110
Steel Tilt Cab Models	Nut	250-300
Steering Gear Adjustments		
Lash Adjuster Screw	Nut	25-35
Side Cover to Housing	Bolt	25-35
Worm Bearing Adjuster Plug		
Except 568-DV-64	Nut	50-110
Type 568-DV-64	Nut	50-75
Control Valve to Steering Gear		
Except 568-DV-71	Bolt	35-45
Control Valve Adapter to Steering Gear		
Type 568-DV-71	Bolt	25-30
Control Valve to Adapter Type 568-DV-71	Bolt	15-20
Pressure Hose Union	—	30-40
Hose Fittings to Ports	—	20-30
Power Steering Cylinder Anchor Bracket to Frame Bolt	Nut	50-60
Power Steering Cylinder Anchor Bracket to Axle Bolt	Nut	50-60
Power Steering Cylinder to Pitman Arm Stud*	Nut	125-150
Power Steering Cylinder Anchor Bracket to Tie Rod U-Bolt	Nut	35-45
Power Steering Cylinder Ball Stud Socket Clamp Bolt	Bolt	50-60

LOCATION	TYPE OF PART	TORQUE (FT.-LBS.)
Power Steering Cylinder to R.H. Idler Arm		
Stud* With F-160 Front Axle	Nut	125-150
Support Bracket to Frame Bolt	Nut	50-60
Idler Arm to Idler Shaft Clamp Bolt	Nut	80-90
Drag Link to Pitman Arm Stud*		
Drag Link to Idler Lever Stud*		
Series RM-7500	Nut	125-150
Tilt Cab Models	Nut	125-150
Drag Link to Steering Arm Stud*	Nut	125-150
R.H. Drag Link to Idler Arm Stud*		
With F-160 Front Axle	Nut	125-150
Power Steering Junction Block to Frame Bolt		
With F-160 Front Axle	Nut	20-25
Reservoir Mounting Bracket to Support	Bolt	20-25
Reservoir to Mounting Bracket	Bolt	20-25
Oil Cooler to Support Bracket	Bolt	10-15
Vane Type Hydraulic Pump		
Mounting Bolt or Stud	—	25-40
Port Fitting	—	25-40
Slipper Type Hydraulic Pump		
Reservoir Cap Screw	—	15-20
Pressure Relief Valve	—	30
Front Insert Nut	—	95-105
Tie Rod to Steering Arm Stud*		
Except F-070 Front Axle	Nut	125-150
With F-070 Front Axle	Nut	230-250
Tie Rod End Clamp Bolt		
Except F-070 Front Axle	Nut	65-75
With F-070 Front Axle	Nut	80-100

*Tighten Nut to Specified Torque, Then Advance to Next Aligning Slot and Install a New Cotter Pin to Secure.

SECTION 10
WHEELS AND TIRES

GENERAL

Wheels used on vehicles covered in this manual are either Disc-type (fig. 1) or Cast-type (fig. 2). On cast wheels, tires are mounted on rims which are secured on wheel with rim clamps and nuts. Budd-type front wheels have a single nut, while rear wheels have inner and outer nuts.

WHEEL NUT TIGHTENING SEQUENCE

On a new vehicle, or after a wheel has been changed, the wheel nut torque must be checked at intervals of 100, 500, 1,000, and every 1,000 miles thereafter.

NOTE: Wheel hub flanges, wheels, studs, and stud nuts should be free of rust, lubricants, dirt, and finish color paint on all "faying" surfaces to ensure proper torque retention.

CAST SPOKE WHEEL (Fig. 3)

1. Install tire and rim assembly to axle hub.
   a. Install rim spacer (rear only).
   b. Install outer rear tire and rim assembly. With valve stem opposite valve stem on inner tire and rim assembly.
2. Install rim clamps and nuts. Position and finger tighten.
3. Starting at bottom, tighten No. 1 nut to 15 to 20 foot-pounds torque.
4. Torque nuts 2, 3, 4, 5, and 6 (if used) using indicated sequence to 190 to 210 foot-pounds.
5. Retorque nut No. 1 to 190-210 foot-pounds.
6. Wheel clamps must be seated following wheel circumference.

CAUTION: DO NOT TIGHTEN NUT WITH CLAMP IN COCKED POSITION.

7. Wheel runout measured at the tire side wall should not exceed 1/8-inch on front wheels and 3/16-inch on rear wheels.

DISC-TYPE WHEELS (Fig. 4)

1. Install tire and wheel assembly to axle hub.
2. Install all nuts loosely. Finger tighten inner wheel nuts (rear) or wheel nuts (front) marked by arrows.
3. Then, tighten nuts to specified torque in sequence illustrated.
4. Install outer rear tire and wheel assembly with valve stem opposite valve stem on inner tire and wheel assembly.
   a. Install and finger tighten outer nuts marked by arrows.

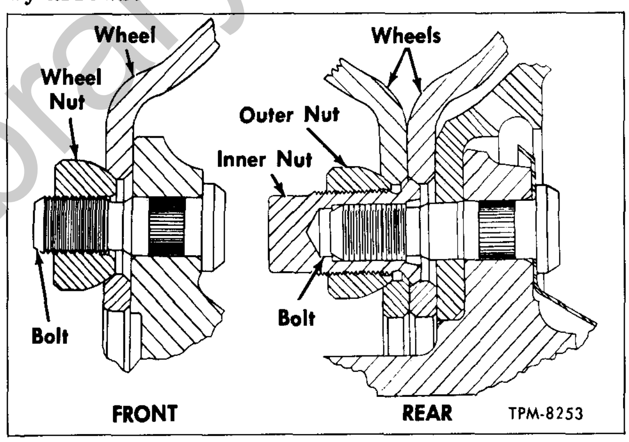


Figure 1—Budd Type Wheels Shown

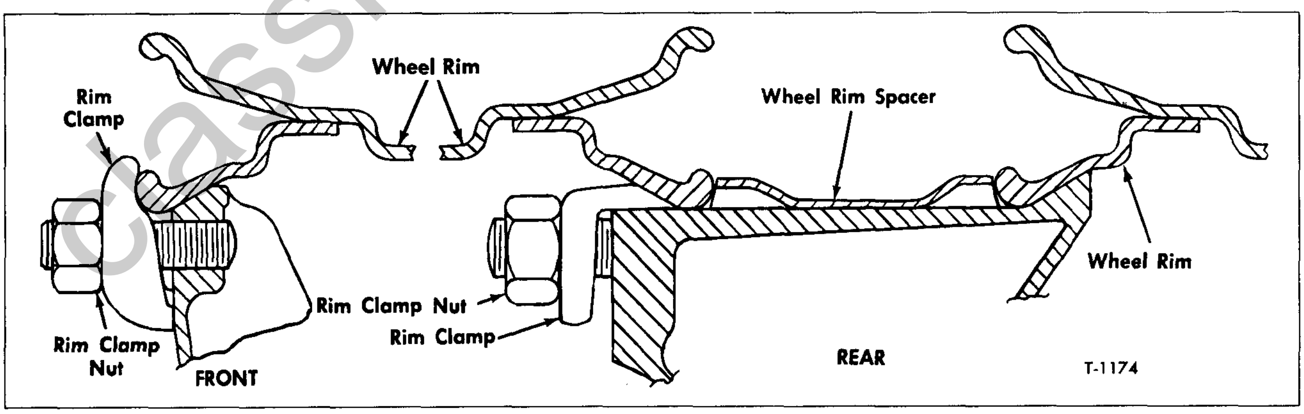


Figure 2—Cast Type Wheel Rims (Typical)

b. Then, tighten to specified torque in sequence illustrated.

5. Torque requirements:
Disc (Except Budd Type) - 300-400 ft.-lbs.
Disc (Budd) - 500-550 ft.-lbs.

NOTE: All Budd-type inner and outer nuts used on the right side of the vehicle have right-hand threads. All inner and outer nuts used on left side have left-hand threads. Both inner, and outer nuts are appropriately stamped with the letter "L" to signify left-hand or "R" to signify right-hand. Care should be exercised to prevent trying to use the wrong thread nut for the respective side, as damage to the stud threads could occur.

WHEEL STUDS OR BOLTS AND NUTS

If any wheel experiences a single stud failure caused by a loose-running wheel, all studs should be replaced. A loose-running wheel may cause only one stud to break, but more studs could be fatigued to the point of failure, but not easily noticeable. Replacing only the one broken stud and remounting the wheel could then promote further and possibly serious failure. If stud holes in wheels have become elongated or distorted, replace the wheel.

NOTE: These wheel to hub stud and nut fasteners are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

DUAL WHEELS

When installing dual wheels, position valve stems 180 degrees apart (Disc-Type) or as close to 180 degrees as possible (cast-type).

On Budd-type dual wheels, loosen outer nuts before attempting to torque inside nuts, then torque outside nuts.

WHEEL INSPECTION (DISC TYPE)

IMPORTANT: Use only parts free from damage or heavy rust, especially at area of contact between rim base and side ring and/or lock ring.

Do not use wheels with bent rims. The continued use of such wheels will result in excessive tire wear and, if wheel is mounted on front of vehicle, difficulty in steering will be experienced. Wheels that are thought to be distorted may be checked as follows, referring to typical diagram (fig. 5) for checking points.

1. Raise axle at side to be checked and safely support underneath.

2. Tool for checking run-out may be readily improvised as follows, secure block of wood approximately 6" x 6" x 14" or material with suitable base so it will remain positioned. Secure thin piece of wood or suitable material 10 inches long, such as ruler or yardstick, and fasten to wood block to

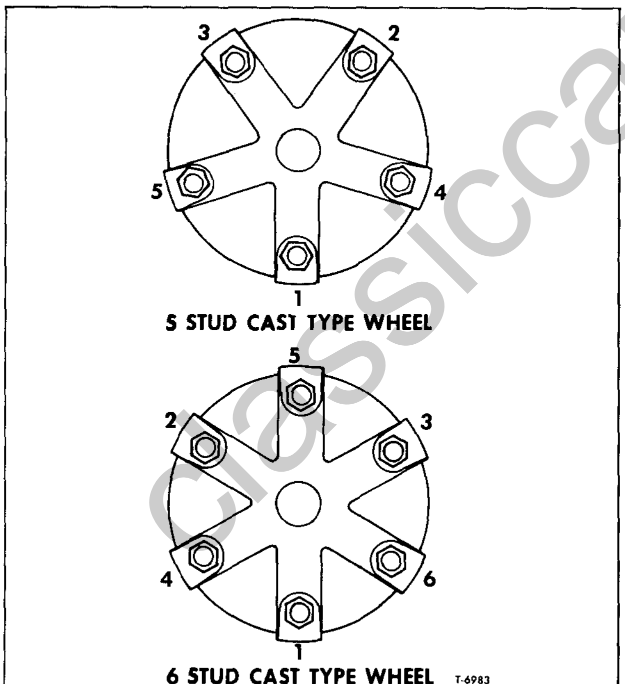


Figure 3—Wheel Nut Tightening Sequence (Cast Type Wheels)

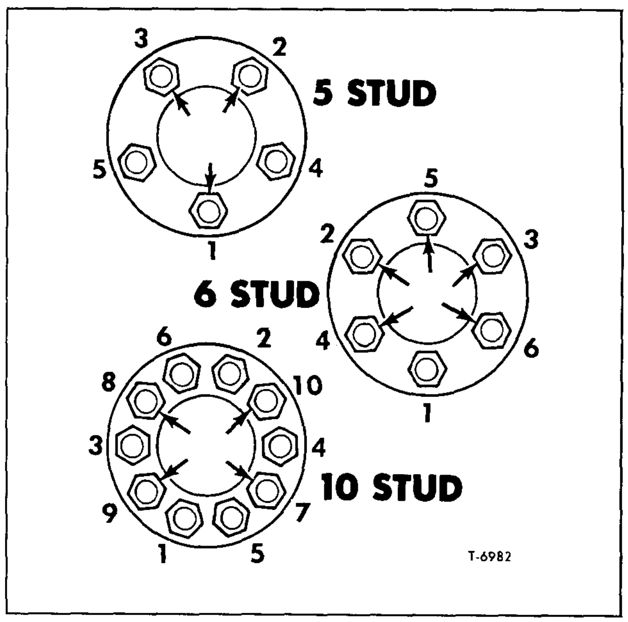


Figure 4—Wheel Nut Tightening Sequence (Disc Type Wheels)

a height in relation to rim surfaces as shown in figure 5. Tighten screw sufficiently so pointer will hold its position when adjusted.

3. Position pointer at crown of rim ("A," fig. 5). Slowly revolve wheel and move pointer toward wheel until it contacts wheel at nearest point.

4. Continue to revolve wheel and check amount of lateral run-out (amount of wheel side wobble). This should not exceed 3/32-inch.

5. Place point of marker at inside of wheel at point "B," figure 5. Follow the above procedure to check radial run-out (out-of-round condition) this should not exceed 3/32". If wheel is distorted beyond these dimensions it should be replaced.

6. If doubt exists whether the wheel or hub is distorted, hub may be checked as follows: Replace the existing wheel with a wheel known to be true. Revolve wheel and make the previously mentioned tests. If tests are within limits the hub is satisfactory, but wheel is sprung.

7. A dismounted wheel may be checked for side wobble by placing straight-edge on face or hub of wheel. Measure distance from straight edge to wheel rim, this should be checked at four equally spaced locations.

NOTE: Additional instructions on balancing wheel and tire assemblies are included under "Wheel and Tire Balancing" later in this section.

TIRES

Tube-type tires are standard and optional on all vehicles covered in this manual. For proper tire repair, go to your Chevrolet dealer or to a reliable tire repair shop.

One of the most important factors of economical and safe truck operation is systematic and correct tire maintenance. The tires must not only support the weight of the loaded vehicle, but they also serve to transmit driving and braking forces to road surface. Therefore, the tires used on all trucks should receive the same amount of careful, systematic, and regular maintenance as do other operating units.

The three major causes of tire troubles are (1) underinflation, (2) overinflation, and (3) misalignment. Tires should be checked periodically to prevent excessive damage caused by these conditions.

INFLATION OF TIRES

Underinflation is the greatest cause for loss of tire life expectancy. Tires should be checked frequently for this condition. The fabric, rubber, bead, contour, and size of tires used on these vehicles are designed to obtain maximum length of service under all operating conditions to which vehicles may be subjected. TIRES ARE DESIGNED TO OPERATE EFFICIENTLY ONLY ON A PRESCRIBED AMOUNT OF AIR. Unless the correct air pressure is consistently maintained, the tires will not function as they should; consequently, safe economical operation of vehicle will be materially affected.

An underinflated tire runs sluggishly, heats up quickly because of the greater flexing, and is subjected to more,fequent bruising. On the other hand, overinflation may weaken the tire, causing a blow-out. In addition to the deteriorating effect improperly inflated tires may have on the tire life, this condition will affect steering, riding comfort, fuel and tire economy, and safe driving. FOLLOW THE TIRE PRESSURE RECOMMENDATIONS OF THE TIRE MANUFACTURER.

For greater riding comfort, prolonged tire life, and to reduce wear and tear on the truck chassis, tires should be inflated for loads carried on tires as indicated in "Tire Load and Inflation Table" in "Specifications" at end of this section. In no case should this combined front and rear tire load exceed the maximum recommended load shown in "Load Capacity Chart" in the current Owner's and Driver's Manual.

BALANCED INFLATION

The whole efficiency of the vehicle will be upset if air pressure in the tires are out of balance. Balanced inflation may be expressed as: All tires on the same axle should always carry the same air pressure. A difference in air pressure of the rear tires and the front tires may be permissible within certain limitations; however, there should not be a difference in pressure between the right and left tires on the same axle. A five-pound

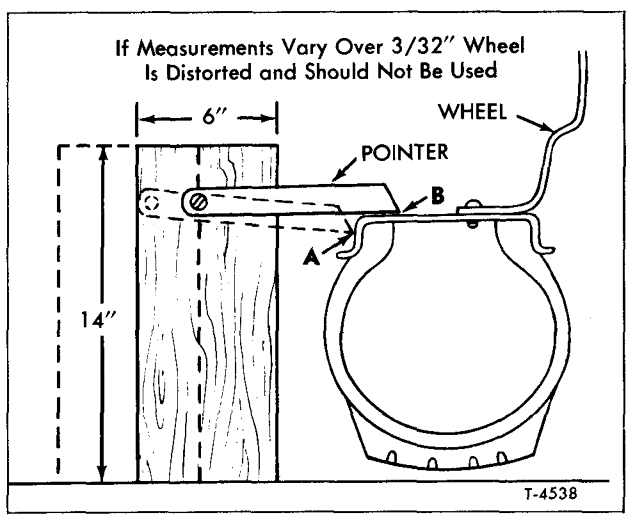


Figure 5—Method of Checking for Distorted Wheels

under-inflation in one front tire not only can destroy ease of steering, but creates steering hazard which generally point to a potential accident. An under-inflated rear tire can destroy the value of the most efficient brakes. Balance tires for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maximum tire mileage.

PRESSURE LOSS

At periodic intervals, each tire should be gauged for pressure loss with an accurate gauge before tires are brought to correct operating pressure. The purpose of this check is to determine the exact pressure loss in each tire. In other words, if at the time this check is made, a definite pressure loss is noted in any one of the tires, an inspection should be made of the tire showing the loss and the cause of loss corrected. This method should definitely establish a "danger signal" on the condition of the tires. The pressure loss check should be made consistently with the same gauge, so that any element of inaccuracy in the gauge will be the same for all tires.

VALVE CORE

The valve core is a spring-loaded check valve in the valve stem, permitting inflation or deflation of the tube or tire. This check valve, or core, is not intended to hold the air during operation. The valve cap is provided to seal the air in the tube and tire. When valve cap is tightened down on stem, the sealing washer inside cap is pressed tightly against top of stem, preventing air leakage. It is important, therefore, that valve caps be used at all times.

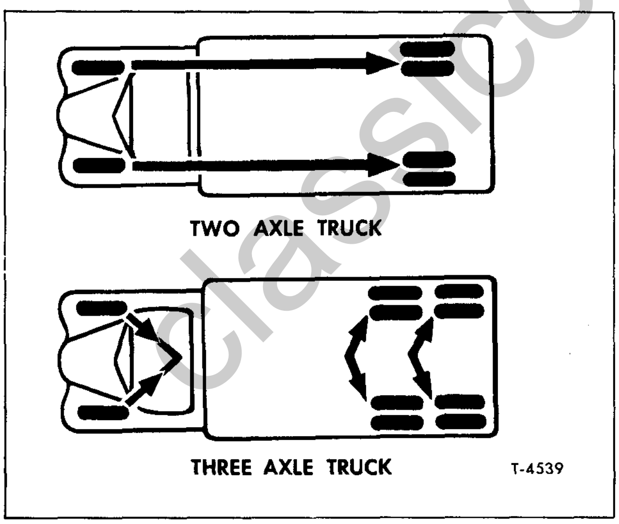


Figure 6—Tire Rotation Diagram

SELECTION OF TIRES

All tires on an axle should, whenever possible, be of the same make, since difference in design and tread in some instances result in unequal tire rolling radii. On trucks equipped with one rear axle, and on trucks equipped with tandem drive rear axles having an interaxle differential, dual tires should have the same overall diameter within ½-inch. On tandem drive rear axles without an interaxle differential, tires should be matched within closer limits to assure maximum tire life, axle life, vehicle performance, and fuel economy. Tires having the same overall diameter within 1/8-inch should be used. Furthermore, the sum of the diameters of the four tires on the forward driving axle should equal the sum of the diameters of the four tires on the rear driving axle. In highway service, the smaller of the two tires on a dual assembly should be installed on the inside position, provided its diameter is within the tolerance described above.

TIRE ROTATION

TWO-AXLE TRUCK (Fig. 6)

Tires should be moved from front to rear after 1/3 of the life of the tread is worn off. If there is uneven tread wear on front tires, rotate tires immediately and check vehicle for mechanical irregularities. When tires are moved to rear, follow the recommendations previously described under "Selection of Tires" in matching them with other tires.

THREE-AXLE TRUCK (Fig. 6)

Since there are five tires on each side of the vehicle, the front tires should be moved to the rear when 1/5 of the tread life has been used. Match tires as previously described under "Selection of Tires."

WHEEL AND TIRE BALANCING

It is desirable from the standpoints of tire wear and vehicle handling ease to maintain proper balance of front wheel and tire assemblies on all models. All wheels intended for use on front of vehicle, such as those switched during periodic tire rotation and those installed as new or repaired replacement equipment, should be accurately balanced. This may be accomplished by either of two types of balancing systems in current use which balance wheels either on the vehicle or off. The "On-The-Vehicle" type, however, is the more desirable in that all rolling components (brake drums, bearings, seals, etc.) are included in the balancing procedure and thereby have any existing unbalance corrected.

Wheel balance is the equal distribution of the weight of the wheel and tire assembly around the axis of rotation. There are two ways in which wheels can be balanced - statically and dynamically; wheels must be statically balanced before they can be balanced dynamically.

STATIC BALANCE

Static balance (sometimes called still balance) is the equal distribution of weight of the wheel and tire assembly about the axis of rotation in such a manner that the assembly has no tendency to rotate by itself, regardless of its position. For example: A wheel with a chunk of dirt on the rim will always rotate by itself until the heavy side is at the bottom. Any wheel with a heavy side like this is statically out-of-balance. Static unbalance of a wheel causes a hopping or pounding action (up and down) which frequently leads to wheel "flutter" and quite often to wheel "tramp."

DYNAMIC BALANCE

Dynamic balance (sometimes called running balance) means that the wheel must be in static balance, and also run smoothly at all speeds on an axis which runs through the centerline of the wheel and tire and is perpendicular to the axis of rotation.

To insure successful, accurate balancing, the following precautions must be observed:

Wheel and tire must be clean and free from all foreign matter. The tires should be in good condition and properly mounted with the balance mark on the tire, if any, lined up with the valve.

Bent wheels that have runout over 3/32" should either be replaced or straightened before being balanced.

NOTE

Inspect tire and wheel assembly to determine if an eccentric or out-of-round condition exists. Note that this condition, if severe, cannot be "balanced out." An assembly which has an out-of-round condition exceeding 5/16" on 8.25:20 tires and up, is not suitable for use on the front of the vehicle. Its use on the rear should be governed by its general condition and whether the roundness defect seriously detracts from overall ride quality.

When balancing wheels and tires, it is recommended that the instructions covering the operation of the wheel balancer being used be closely followed.

SYNTHETIC TUBES

When installing synthetic tubes, coat both sides of the flap (if used), inner diameter of tube, and inside of tire beads with a solution of neutral vegetable oil soap. Use a brush or cloth swab to apply. Do not allow solution to run down into tire. This treatment aids tube in shaping itself properly during inflation. When tube and flap are not properly lubricated, tube will be stretched thin in the tire bead and rim regions.

It is a good practice to remove valve core after partially inflating tube. This will aid tube to seat properly in tire and help prevent tube wrinkles. Install valve cap to valve stem when correctly inflated.

TIRE MOUNTING

Tires may be secured on rims by a one-piece split lock ring, or by a continuous side ring held in place by a split lock ring. Conventional methods are used to mount and dismount tires.

CAUTION

Most truck "rim accidents" are caused by carelessness and thoughtlessness when inflating the tire after mounting. Such accidents are always serious and sometimes fatal. Be on the safe side -- always follow the precautions explained below:

On all rims, the lock ring must be fully seated in the rim gutter before inflating tire. This is important for the safety of the person inflating the tire. As a safety measure, observe the following precautions:

On Budd-type wheels, use a steel bar approximately 1-inch in diameter and long enough to extend several inches past diameter of the lock ring at both ends. Bend bar slightly in center so it can be inserted through wheel spoke openings with both ends of bar extending over and past the lock ring. Leave bar in place until tire is fully inflated, examine lock ring to see that it is fully seated, then remove safety bar.

On cast-type wheels, wrap around tire and rim with a chain at opposite sides of rim and secure ends of chain. Leave chain loose enough to permit expansion of tire during inflation. After inflating, examine lock ring to see that it is fully seated, then remove chain.

IMPORTANT

When servicing wheels, make sure mating side rings, and/or lock rings are kept together in sets. Also, when it is necessary to replace any of the parts make sure they are the same as those removed and that lock ring seats properly in rim.

SPECIFICATIONS

WHEEL NUT TORQUE

Cast Type Wheels

Tighten nuts as directed in text to:
- Front .... 190-210 foot-pounds
- Rear .... 190-210 foot-pounds

Budd Type Wheels

Tighten nuts as directed in text to:
- Front .... 500-550 foot-pounds
- Rear (Inner and outer nuts*) .... 500-550 foot-pounds

*Loosen outer nuts, tighten inner nuts, then tighten outer nuts.

TIRES FOR TRUCKS IN HIGHWAY SERVICE LOAD AND INFLATION TABLE

Tire and Rim Association Standard Tire Loads At Various Inflation Pressures.

TIRES USED AS SINGLES

TIRE IDENTIFICATION		TIRE LOAD LIMITS AT VARIOUS INFLATION PRESSURES										
SIZE	LOAD RANGE	50	55	60	65	70	75	80	85	90	95	100
8.25-20	E	2800	3010	3190	3370	3560	3730	3890	4050			
8.25-20	F	2800	3010	3190	3370	3560	3730	3890	4050	4210	4350	4500
9.00-15	F		2950	3150	3330	3500	3660	3830	3980	4140	4290	
9.00-18	E		3320	3530	3730	3920	4120	4300				
9.00-20	E		3560	3770	4000	4210	4410	4610				
9.00-20	F		3560	3770	4000	4210	4410	4610	4790	4970	5150	
10.00-15	F			3580	3780	3980	4170	4370	4540			
10.00-15	G			3580	3780	3980	4170	4370	4540	4710	4880	5050
10.00-18	F			4000	4230	4460	4660	4880	5070			
10.00-20	F			4290	4530	4770	4990	5220	5430			
10.00-20	G			4290	4530	4770	4990	5220	5430	5640	5840	6040
10.00-22	F			4560	4820	5070	5310	5550	5780			
10.00-22	G			4560	4820	5070	5310	5550	5780	6000	6210	6430
10.00-24	F			4830	5120	5380	5640	5890	6130			
11.00-20	F			4670	4940	5200	5450	5690	5920			
11.00-20	G			4670	4940	5200	5450	5690	5920	6140	6370	6590
11.90-20	H			4670	4940	5200	5450	5690	5920	6140	6370	6590
11.00-22	F			4960	5240	5520	5790	6040	6290			
11.00-22	G			4960	5240	5520	5790	6040	6290	6530	6770	7000
11.00-24	F			5270	5570	5860	6140	6420	6680			
12.00-20	G				5620	5920	6200	6480	6740	7000		
12.00-22	G				5970	6280	6590	6870	7160	7430		
12.00-24	G				6330	6660	6980	7280	7580	7880		

NOTE: Underlined Figures Indicate Maximum Recommended Load.

SPECIFICATIONS (CONT.)

TIRES USED AS DUALS

TIRE IDENTIFICATION		TIRE LOAD LIMITS AT VARIOUS INFLATION PRESSURES										
SIZE	LOAD RANGE	40	45	50	55	60	65	70	75	80	85	90
8.25-20	E	2460	2640	2800	2960	3120	3270	3410	3550			
8.25-20	F	2460	2640	2800	2960	3120	3270	3410	3550	3690	3820	3950
9.00-15	F		2590	2760	2920	3070	3210	3360	3490	3630	3760	
9.00-18	E		2910	3100	3270	3440	3610	3770				
9.00-20	E		3120	3310	3510	3690	3870	4040				
9.00-20	F		3120	3310	3510	3690	3870	4040	4200	4360	4520	
10.00-15	F			3140	3320	3490	3660	3830	3980			
10.00-15	G			3140	3320	3490	3660	3830	3980	4130	4280	4430
10.00-18	F			3510	3710	3910	4090	4280	4450			
10.00-20	F			3760	3970	4180	4380	4580	4760			
10.00-20	G			3760	3970	4180	4380	4580	4760	4950	5120	5300
10.00-22	F			4000	4230	4450	4660	4870	5070			
10.00-22	G			4000	4230	4450	4660	4870	5070	5260	5450	5640
10.00-24	F			4240	4490	4720	4950	5170	5380			
11.00-20	F			4100	4330	4560	4780	4990	5190			
11.00-20	G			4100	4330	4560	4780	4990	5190	5390	5590	5780
11.00-22	F			4350	4600	4840	5080	5300	5520			
11.00-22	G			4350	4600	4840	5080	5300	5520	5730	5940	6140
11.00-24	F			4620	4890	5140	5390	5630	5860			
12.00-20	G				4930	5190	5440	5680	5910	6140		
12.00-22	G				5240	5510	5780	6030	6280	6520		
12.00-24	G				5550	5840	6120	6390	6650	6910		

NOTE: Underlined Figures Indicate Maximum Recommended Load.

LOAD RANGE DESIGNATION LETTER TO PLY RATING NUMBER CONVERSION CHART

LOAD RANGE LETTER	PLY RATING
E	10
F	12
G	14

IMPORTANT

At regular intervals wheel nuts should be checked for tightness. A noticeable noise or vibration could indicate loose wheel nuts.

SECTION 11

SHEET METAL

Information in this section covers replacement and adjustment of metal and fiberglass components as used on the Conventional Cab Models. Figure 1 illustrates the metal and fiberglass units.

See following index for guide to information contained in this section.

SHEET METAL COMPONENTS

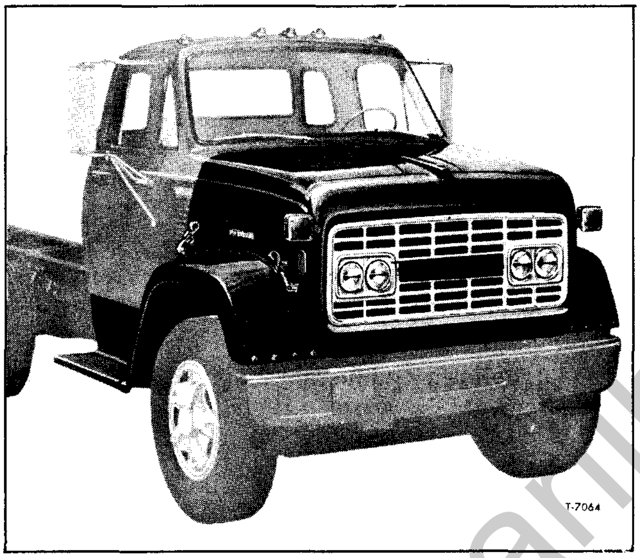


Figure 1—Front End Components (Conv. Cab.) (Typical)

RADIATOR SHELL GRILLE REPLACEMENT

NOTE: It is not necessary to remove grille in order to make head lamp beam adjustments or sealed-beam unit replacement. Notches in grille are provided for this purpose.

1. Remove eight cross-recess screws which attach grille to radiator shell. Remove grille.
2. Place grille in position at radiator shell, then install attaching screws firmly.

RADIATOR SHELL REPLACEMENT

NOTE: The following explains procedure for replacing the radiator shell assembly less the radiator core and support as shown in figure 2, except HM and JM 80 Models which should be removed as a unit. However, the radiator core and support can be left attached to shell if desired as shown in figure 3. This latter method will require the draining of cooling system and disconnecting of radiator hoses.

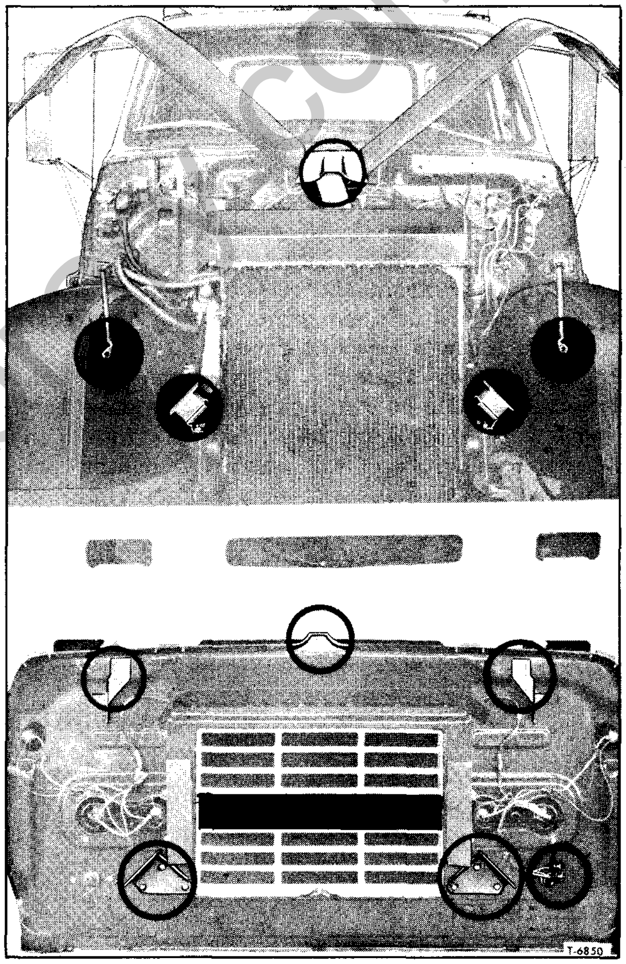


Figure 2—Radiator Shell Replacement (Typical)

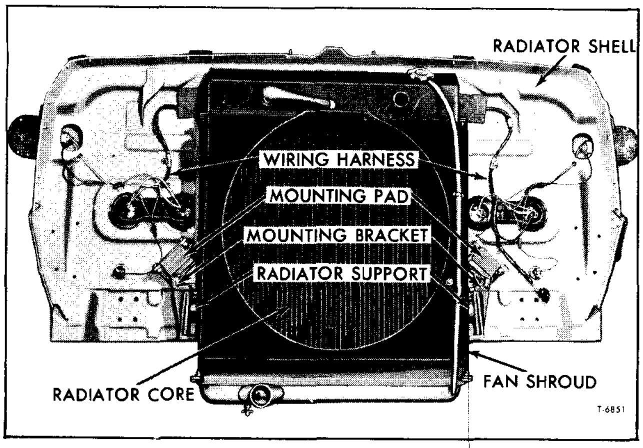


Figure 3—Radiator Shell Removed Showing Core Removed (Typical)

REMOVAL (Refer to Fig. 2)

1. Raise and support hood side panels.
2. Disconnect head lamp wiring harness connector which is located at right side of radiator shell panel. Also, disconnect the wiring harness ground wire which is attached to stud on frame side member with nut and washer.
3. Remove two bolts and nuts which attach hood center panel to radiator shell.
4. Support front end of hood center panel by placing a prop between top of engine and center panel. (See upper view of figure 2.)
5. Remove attaching bolts (number of bolts depends on model) which attach each side of shell to radiator support mounting brackets (figs. 5 and 6), or remove bolts each side at mounting pad.

NOTE: On some models, mounting bracket (fig. 5) is inverted 180 degrees.

6. Remove bolt, nut, and washer which attach each strut rod to shell.

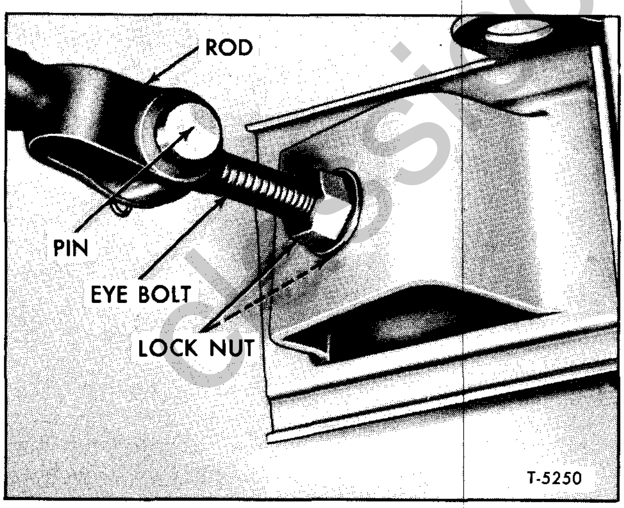


Figure 4—Radiator Shell Strut Rods

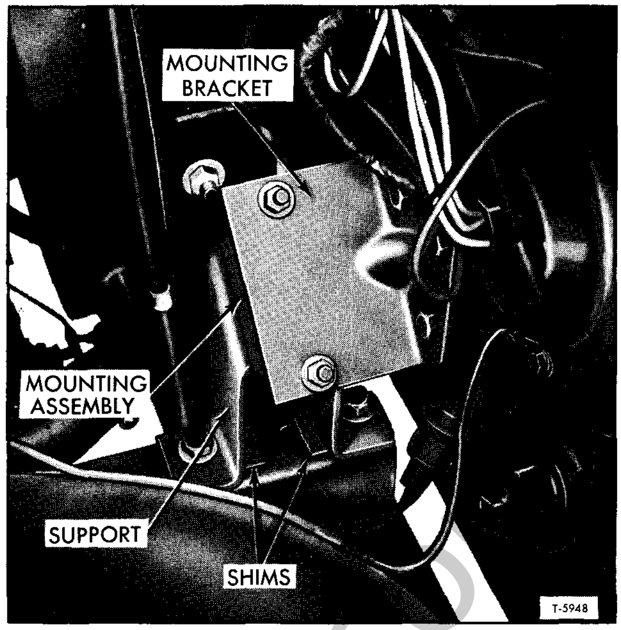


Figure 5—Radiator Shell Flexible Mounting (Typical for HM and JM80)

7. With aid of an assistant to lift radiator shell assembly upward so that radiator core support center bracket clears top of core, move assembly forward from vehicle.

The following additional information will apply on HM and JM 80, or when replacing radiator core and support with radiator shell as an assembly (fig. 3.)

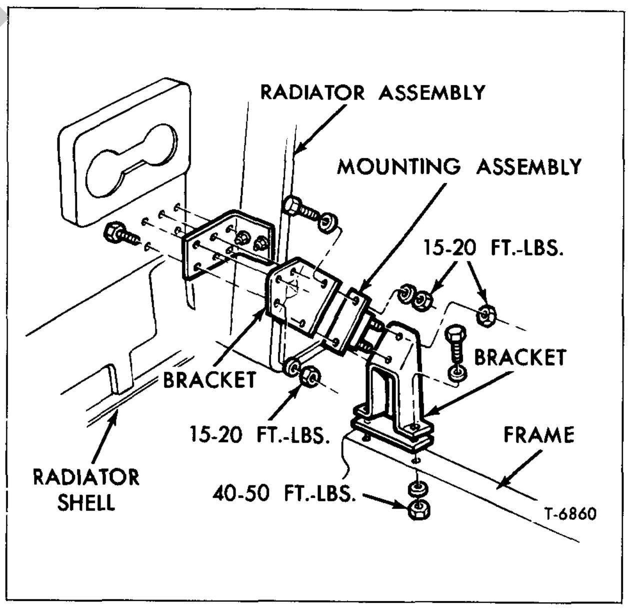


Figure 6—Radiator Shell Flexible Mounting

1. Drain the cooling system and disconnect radiator hoses.

2. If radiator assembly includes oil cooler, make provisions for catching oil drainage from oil cooler ports and lines. Disconnect all coolant hoses and oil lines (if equipped) from radiator core assembly.

3. If vehicle is equipped with air conditioning or power steering cooling coils, remove coils, lines, and brackets, as necessary.

4. On some models it may be necessary to remove fan shroud attaching bolts, then lay shroud back over fan blades.

5. On models except HM and JM 80, remove upper lock nuts, washers, and cushions from radiator stabilizer rods. Refer to RADIATOR AND SURGE TANK (SEC. 13) (fig. 4) of this manual.

Do not move lower lock nuts or jam nuts on strut rod.

NOTE: If necessary to remove hood, refer to "Hood Replacement" later in this section.

Refer to RADIATOR AND SURGE TANK (SEC. 13) of this manual, for removal of radiator from shell.

6. Install radiator shell unit in vehicle in the reverse of removal procedures.

NOTE: If collision repairs were made to front end of vehicle, it may be necessary to realign the shell and hood panels, using means of threaded yoke on radiator shell support strut rods (fig. 4). By shortening or lengthening rods, top of radiator core and shell can be tilted fore and aft to obtain proper hood alignment.

RADIATOR SHELL MOUNTING BRACKET REPLACEMENT

1. Secure adequate support for the radiator core (when involved) and radiator shell sheet metal, as these components will drop when support bracket is removed.

2. Remove all bolts, nuts and washers securing mounting bracket to frame rail, to radiator shell and to radiator core support (if involved).

3. Remove mounting bracket (fig. 5 or 6). In some cases bracket may be further disassembled for inspection.

4. Replace worn mounting pads or cushions and assemble bracket if necessary.

5. Install mounting bracket components in reverse of above procedures.

FENDER ASSEMBLY REPLACEMENT

NOTE: The following describes procedure for replacing the complete fender assembly which includes components shown in figure 7.

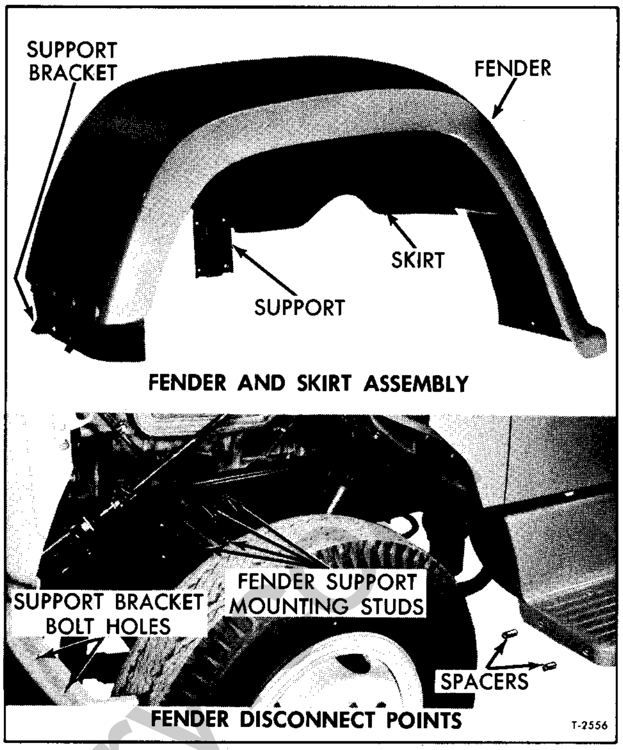


Figure 7—Fender Replacement (Typical)

REMOVAL

1. Remove two bolts, nuts, and washers which attach bumper to fender front support bracket.

2. At rear of fender, remove two bolts, bolt spacers, nuts, and washers which attach fender to running board.

3. Remove nuts from four studs which attach fender support to frame side rail. Lift fender assembly from vehicle.

NOTE: If desired, the skirt and fender support can be readily separated from fender.

INSTALLATION

Assemble fender and skirt if necessary, then install fender assembly in reverse of "Removal procedures.

NOTE: If all attaching hardware is installed loosely, components can be readily aligned before final tightening.

RUNNING BOARD REPLACEMENT

(Refer to Figure 8)

REMOVAL

1. Remove two bolts, nuts, and washers which attach running board to fender. Remove bolt spacers.

2. Remove four bolts and lock washers which attach running board to frame supports. Remove running board.

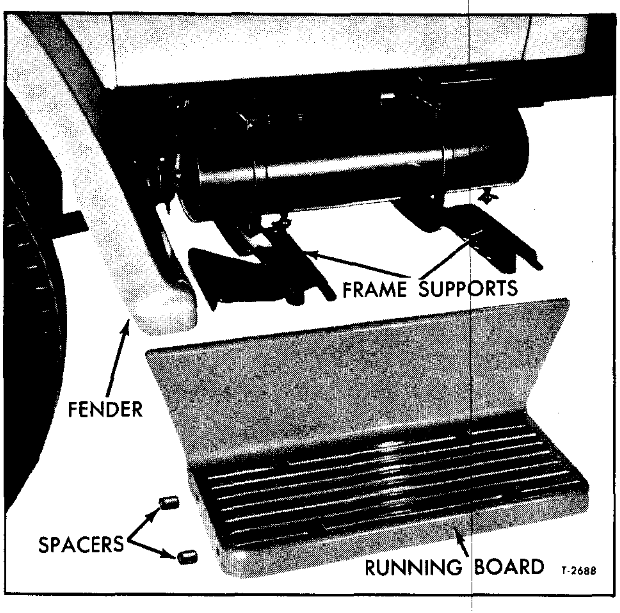


Figure 8—Running Board Replacement

INSTALLATION

1. Place running board in position on frame supports, then install loosely, four attaching bolt nuts and lock washers.
2. With bolt spacers held in position at fender, install bolts, flat washers, lock washers and nuts which attach running board to fender.

NOTE: Bolt holes at front of running board and in the frame supports are slotted for purpose of obtaining proper alignment with fender outer surface which should be flush.

3. Align running board with fender, then final tighten all attaching bolts and nuts.

HOOD ASSEMBLY REPLACEMENT

NOTE: The separate halves of hood assembly can be readily replaced after first marking the hinge-to-hood panel positions, then removing the hinge bolts.

The following describes procedure for replacing the complete hood assembly which includes the right and left, and center panels.

REMOVAL (Refer to Fig. 9)

1. Raise both hood side panels and support with attached props.
2. At front of hood center panel, remove two attaching screws, washers, and nuts.
3. Underneath hood center panel, at the rear, remove two nuts and washers which attach center panel mounting cushion assemblies to cab bracket.
4. With the aid of an assistant, carefully lift the hood assembly from vehicle using care not to twist it.

INSTALLATION

Install the hood assembly in reverse of the "Removal" procedure.

NOTE: If collision repairs were made or if new sheet metal parts were installed, it may be necessary to realign the sheet metal. This can be accomplished by changing the length of the radiator shell strut rods, one at each side of the radiator core (fig. 4).

NOTE: Slotted mounting bolt holes at rear of hood center panel are provided to allow fore and aft movement at top of shell. If necessary, loosen adjustable sleeve clamps on struts, then

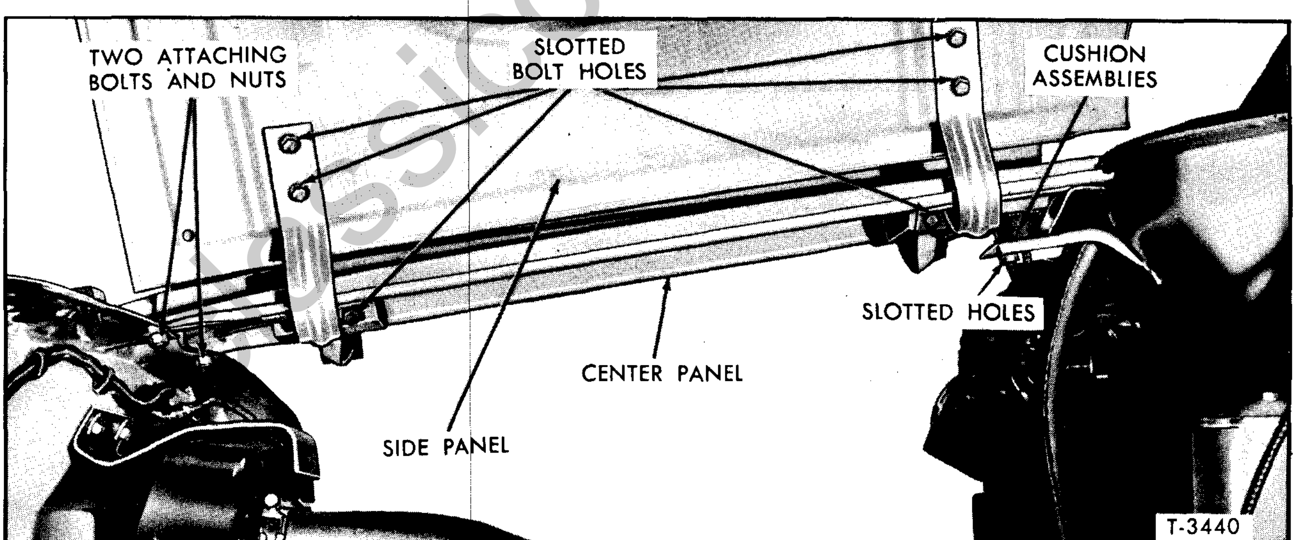


Figure 9—Hood Center Panel Mounting

turn sleeve as required to obtain good front end sheet metal alignment. After making adjustments, tighten sleeve clamps.

Each half of hood assembly is adjustable in side opening by means of slotted attaching bolt holes in the two hinge straps. If necessary, loosen hinge strap bolts and reposition hinge. After making adjustment, tighten attaching bolts firmly.

IMPORTANT

DO NOT OVER-ADJUST TO CAUSE ENGINE FAN TO CONTACT CORE. Adjustment to this extreme would indicate collapsed mountings at engine or cab.

FIBERGLASS COMPONENTS

RADIATOR SHELL GRILLE REPLACEMENT

See same subject under "Sheet Metal Components."

FIBERGLASS HOOD REPLACEMENT

NOTE: Figure 10 shows fiberglass hood assembly removed.

IMPORTANT: The aid of an assistant is required to replace the hood assembly properly.

REMOVAL

1. Disconnect front light wiring harnesses and ground wire at front end near frame rail.
2. Remove the bolt, nut, and lock washer from hood right and left side hinge pins.
3. Support weight of hood at each hinge pin, then pull the pin from hinge. Lower hood tc allow hinge straps to rest on front bumper.
4. Position assistant to support weight at front center of hood, then disconnect the hood stop cable special bolts at radiator support side brackets. (See fig. 11.)
5. At each side, lift hood assembly from over front bumper, then remove the hood from the vehicle.
6. If necessary, all components of hood assembly can be readily replaced. Figure 10 illustrates hood components.

If required, hood hinge pin bushings (fig. 12) can be driven from hinge strap and a new rubber bushing pressed into its place.

INSTALLATION

Install the hood assembly by performing the "Removal" procedure in reverse.

NOTE: If necessary, the hood can be aligned

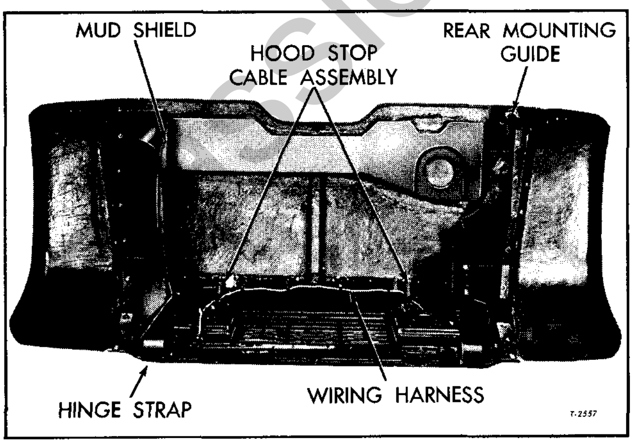


Figure 10—Fiberglass Hood Removed (Typical)

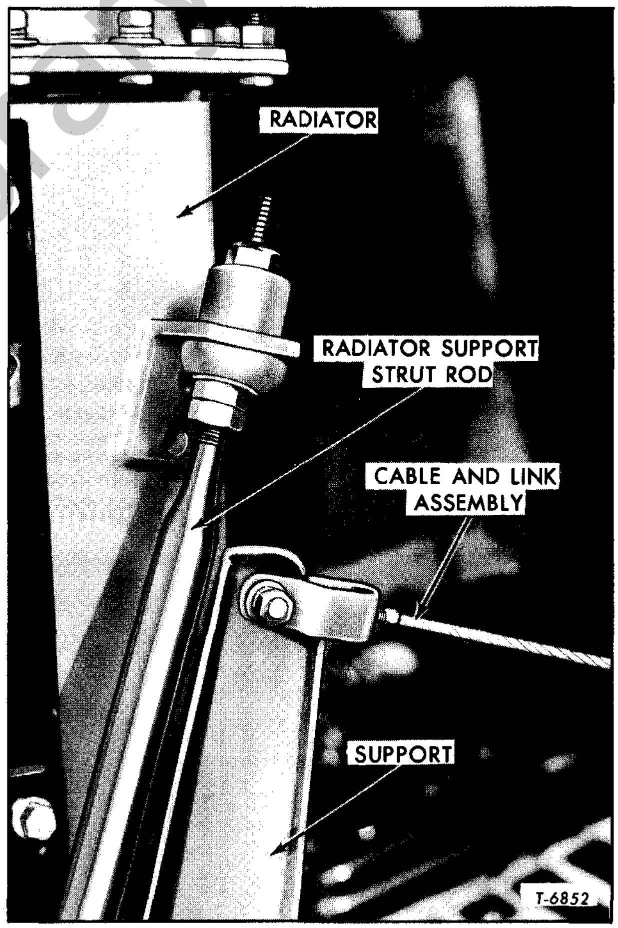


Figure 11—Hood Stop Cable Clevis Installation

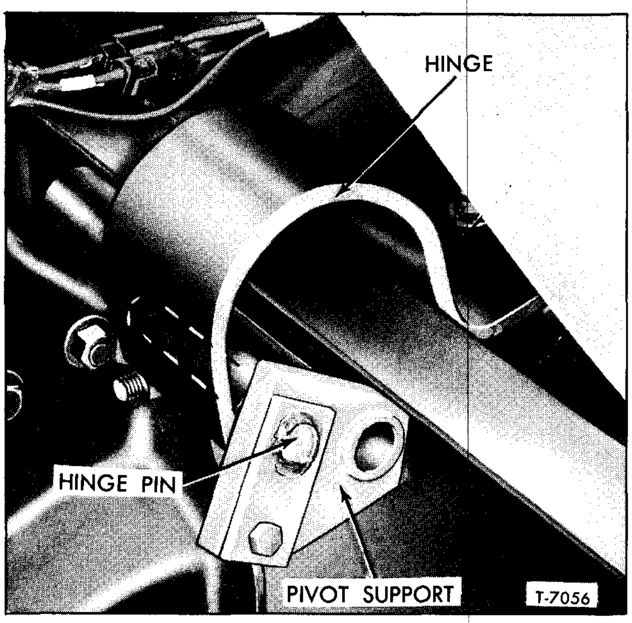


Figure 12—Hood Hinge Pin and Tab

as directed later under "Fiberglass Hood Alignment." Tighten all attaching bolts at points of adjustment.

> IMPORTANT: When installing hood, make sure hood is not allowed to twist.

FIBERGLASS HOOD ALIGNMENT

The hood assembly is adjustable fore and aft by adding or removing shims located between the hood forward panel and the hinge strap (fig. 13). Note the proper position of shims when installed.

The height of hood front end is also adjustable by means of slotted attaching bolt holes in each hinge strap (fig. 13). Loosen strap bolts, then

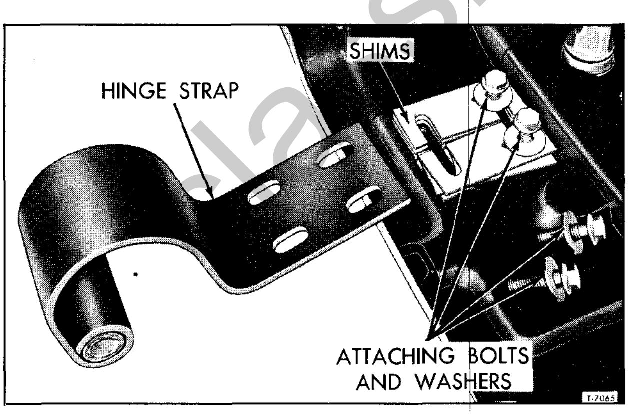


Figure 13—Hood Fore and Aft Adjustment

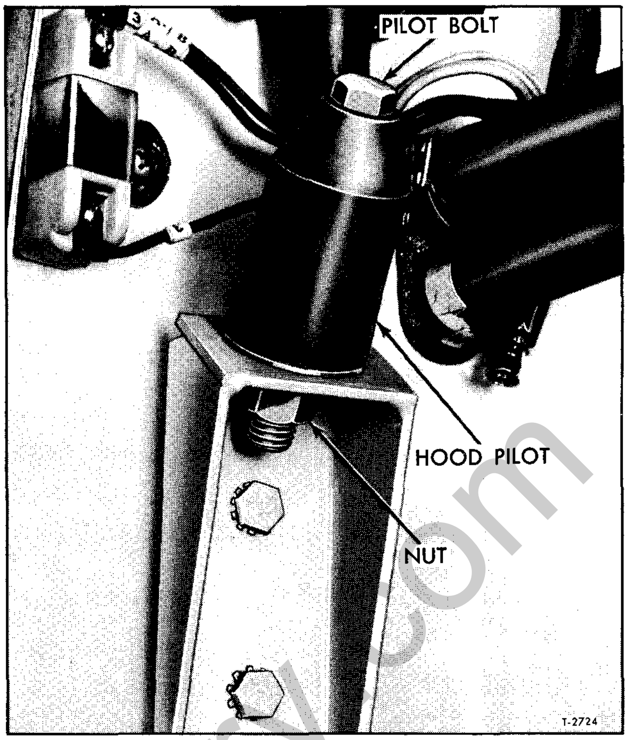


Figure 14—Hood Mounting Adjustment at Cab Cowl (H and J Models Shown)

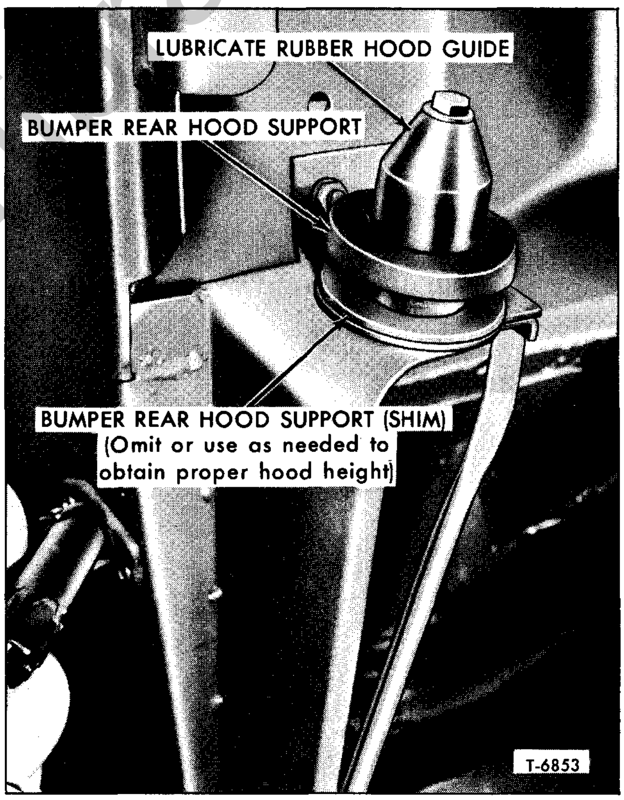


Figure 15—Hood Mounting Adjustment at Cab Cowl (M and C Models Shown)

raise or lower front of hood assembly as required. HOOD SHOULD NOT CONTACT RADIATOR CORE UNIT.

The rubber pilot at each side of hood cowl (figs. 14 and 15) is adjustable in all directions on cowl bracket to stabilize the hood position. To check adjustment, loosen pilot bolt nut, then lower hood onto pilot which should cause pilot to locate itself on cowl bracket. Cowl bracket has an enlarged bolt hole for this purpose. Tighten bolt nut.

FIBERGLASS FENDER EXTENSION REPLACEMENT

REMOVAL

1. Tilt the hood assembly forward.
2. Referring to figure 16, remove five bolts which attach fender extension to the cab and extension support bracket. Remove the extension assembly.
3. Separate the metal brace rod from extension. Note the number of shim washers at lower end of brace rod.

INSTALLATION

Assemble and install extension assembly in reverse of the "Removal" procedures.

For proper alignment with hood, add or remove shims as shown in figure 16.

FENDER SKIRT REPLACEMENT

The fender skirts are mounted directly to the fiberglass hood and may be more readily replaced with the hood removed from the vehicle.

1. If desired, remove fiberglass hood as described previously under "Fiberglass Hood Replacement."
2. Remove all bolts, washers, and nuts which attach fender skirts to hood and braces.
3. If braces are to be replaced, remove bolts attaching braces to hood.
4. Inspect hood fiberglass in area of skirt mounting and repair if necessary.

To install fender skirts, reverse above procedure.

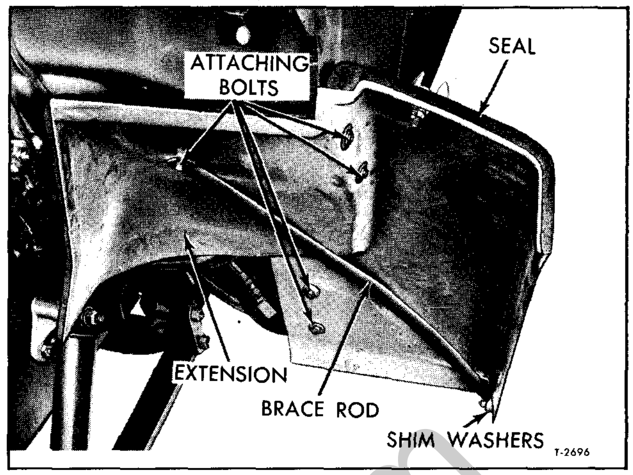


Figure 16—Fiberglass Hood Fender

REPAIR OF FIBERGLASS HOOD AND FENDER COMPONENTS

Repair procedures of fiberglass parts are simple and the paint refinishing procedure is the same as for metal parts.

In general, all repairs to fiberglass parts consist of filling the damaged area (which has been sanded or ground down) with plastic solder or with fiberglass cloth and resin. Use of the various materials is determined by the type of repair to be made. The repair is allowed to harden and then the finishing operations are performed.

Such repairs as large holes, torn sections, and separated joints require the adhesive qualities of resin and the reinforcing qualities of the fiberglass sheets which are available in Repair Kit No. 1050535. Small dents, scratches, surface cracks and pits can be readily repaired after sanding down then using only plastic solder No. 1050112. This part number consists of a 3 lb. container of solder-type polyester resin and one U.S. fl. oz. tube of creme hardener. Instructions for both the mixing and application are located on the solder container. The solder and hardener are included in Kit No. 1050535. However, both the solder and the polyester resin containers with their respective hardeners are available separately.

An illustrated instruction sheet is included in the complete Repair Kit No. 1050535.

When working with fiberglass repair materials, avoid contact with skin and never work near fire or flame. If materials should come in contact with skin, wash thoroughly with soap and water as soon as possible.

SECTION 12

CHASSIS ELECTRICAL AND INSTRUMENTS

This section, covering maintenance and replacement of chassis electrical system units, is divided into sub-sections shown in the Index following:

MISCELLANEOUS ELECTRICAL

NOTE: Certain electrical units, when closely associated with other systems or units, are covered in other sections of this manual as listed below:

Unit	Section
Gauge, Air Restriction (Cummins Only)	6M
Gauge, Engine Oil Temperature	6K
Gauge, Fuel Tank Unit	8
Indicator, Water Temperature	6K
Motor, Air Conditioning Blower	1
Motor, Axle Shift	4A
Motor, Heater Blower	1
Motor, Power Window	1
Motor, Electric W/S Wiper and Washer	1
Relay, Air Conditioning Blower Control	1
Relay, Frequency Sensing	6Y
Relay, Generator Field	6Y
Relay, Starter Control	6Y
Relay, Starter Interlock	6Y
Resistor, Heater Blower Control	1
Sender Unit, Engine Temperature	6K
Sender, Fuel Gauge Tank Unit	8
Speedometer Adapter, 2-Speed Axle	4A
Switch, Air Conditioning Control	1
Switch, Air Cond. Blower Control	1
Switch, Air Stop	5B
Switch, Axle Shift Motor	4A
Switch, 2-Speed Axle Shift	4A
Switch, Differential Lock	4A
Switch, Electric Choke	6M
Switch, Engine Brake	6C
Switch, Engine Brake Clutch	6C
Switch, Engine Overheat	6K
Switch, Fuel Pressure	6C
Switch, Heater Control	1
Switch, Heater Blower Control	1
Switch, Low Air	5B
Switch, Micro Buffer	6C
Switch, Starter Magnetic	6Y
Switch, Windshield Wiper and Washer	1
Solenoid, 2-Speed Axle Air Shift	4A
Tachometer Drive	6A

WIRING DIAGRAMS

Wiring diagrams show electrical circuits and connections for standard and optional equipment used on vehicles covered by this manual. Standard equipment is shown in solid lines on diagrams and optional equipment is shown in broken lines. Truck series to which each diagram applies is shown on each diagram.

NOTE: On Alum Tilt Cab vehicles, a schematic wiring diagram of electrical system is located on inner side of console panel access cover.

WIRING HARNESSES AND WIRES

Some wires are grouped and taped together with a moisture and heat resistant black, plastic-type tape to form a wiring harness. In other instances, it is more practical to use a single wire or cable. Every wire is of a specific size with plain colored or striped insulation as indicated on the wiring diagrams. Insulation colors assist in tracing circuits and in making proper connections.

Connections between chassis wiring harness and the engine, body, and lighting wiring harness are made through a multiple plug and receptacle

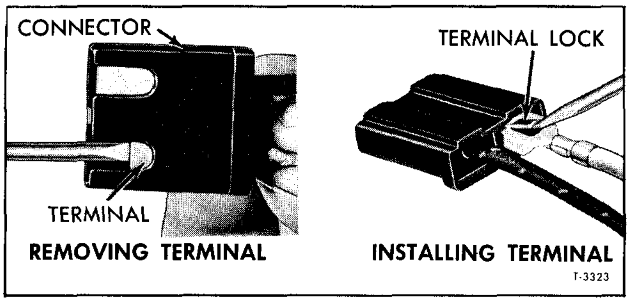


Figure 1—Replacing Blade Type Connector Terminals

type connector or through a terminal post-type chassis junction block. Connections at instrument cluster, gauges, and units are made through multiple plug, and receptacle-type connectors, plastic insulated blade-type connectors, and screw-type terminals.

Each harness or wire must be held securely in place by clips or other holding devices to prevent chafing of insulation.

On vehicles equipped with the V6-401M gasoline engine, a 1.52 ohm resistance wire is used in the engine wiring harness to connect the "IGN" terminal of the ignition switch to the positive (+) terminal of the ignition coil. The proper length wire is used to provide the correct resistance. This wire is identified on applicable wiring diagram as "20-WHT. ORN. & PPL. CR. TR" or "20-BLK." DO NOT use regular copper wire in place of this resistance wire.

The resistor provides increased voltage during engine cranking.

During cranking, a full 12-volts is supplied to the coil by a shunt wire between starter terminal and coil terminal.

On some vehicles, a special resistance wire is used in the charging circuit wiring harness and is connected between the "IGN" terminal on the engine control switch and No. 4 terminal on voltage regulator. When replacing this wire, a wire of same material and length must be used to provide the correct resistance. The wire is identified on applicable Wiring Diagram as 24-BRN. WHT. STR. Resistance value of this wire is approximately 10.0 ± 1.0 ohm, 6.25 watts.

NOTE: On Alum Tilt vehicles, electrical connections at control panel are shown in figure 10.

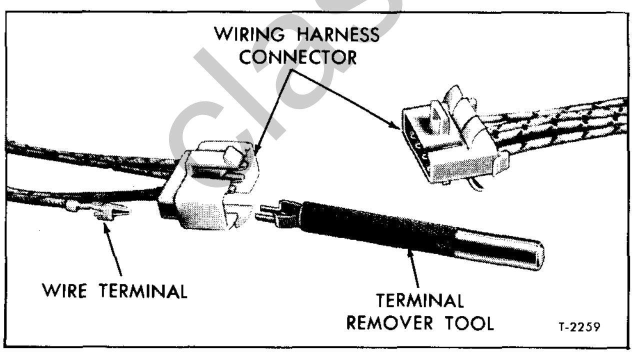


Figure 2—Removing Twin Lock Type Connector Terminals

MAINTENANCE AND REPAIR

All electrical connections must be kept clean and tight. Loose or corroded connections may cause a discharged battery, difficult starting, dim lights, and possible damage to generator and regulator. Wires must be replaced if insulation becomes burned, cracked, or deteriorated.

Whenever it is necessary to splice a wire or repair one that is broken, always use rosin flux solder to bond the splice and insulating tape to cover all splices or bare wires.

When replacing wires, it is important that the correct size wire as shown on wiring diagrams be used. Each harness or wire must be held securely in place by clips or other holding devices to prevent chafing or wearing away the insulation due to vibration.

CAUTION: Never replace a wire with one of a smaller size or replace a fusible link with a wire of a larger size.

IMPORTANT: When replacing fuses, circuit breakers, or flashers, be certain the replacement unit is the same part number as unit being replaced.

Circuits may be tested for continuous circuits or shorts with a conventional test lamp or low reading voltmeter by referring to applicable wiring diagrams.

REPLACING WIRING CONNECTOR TERMINALS

Either blade-type or twin lock-type terminals are used in the wiring harness connectors. Mating ends of the connectors are secured by tang locks which must be disengaged at the same time to separate the connector.

Terminal Removal

1. To remove a blade-type terminal from the connector, disengage lock tangs and separate connector. Insert a thin-bladed instrument under mating end of connector terminal and pry up on terminal being careful not to damage connector. Pull wire and terminal from connector as shown in figure 1.

2. To remove a twin lock type terminal from connector, disengage the lock tangs and separate connector. Insert terminal remover (J-21091) or equivalent, as shown in figure 2 to disengage terminal locks from the connector. Pull wire and terminal from cable connector.

Terminal Installation

NOTE: If original terminals are to be used, pry lock on terminal clips down to assure a firm connection when terminals are inserted into the connector.

ALUM TILT ENGINE HARNESS TO INSTRUMENT PANEL HARNESS CONNECTOR

The 32-terminal connector located in right front of cab on Alum Tilt vehicles is accessible after removing six screws which retain the fiberglass engine wiring harness cover to panel. Terminal letters shown on wiring connector body (fig. 4) correspond to letters on wiring diagrams and in the tabulation which follows. The tabulation lists each terminal letter, the circuit it carries, and the size, color, and pattern of the wire which connects to each terminal.

Connector Replacement

NOTE: Wiring connector terminals should be checked for proper alignment and to ensure that they are properly seated in connector cavities.

1. Remove windshield washer container from below dash panel on passenger side.
2. Remove six screws from fiberglass engine wiring harness cover and remove cover.
3. Insert a 3/8- or 7/16-inch socket through engine harness wiring (fig. 3), then turn retaining bolt out. Remove connector from harness.

NOTE: Retaining bolt will remain in the engine harness connector.

4. The connector feed wire from the battery can be disconnected from the connector feed wire to master circuit breaker switch and headlamp switch (fig. 3).

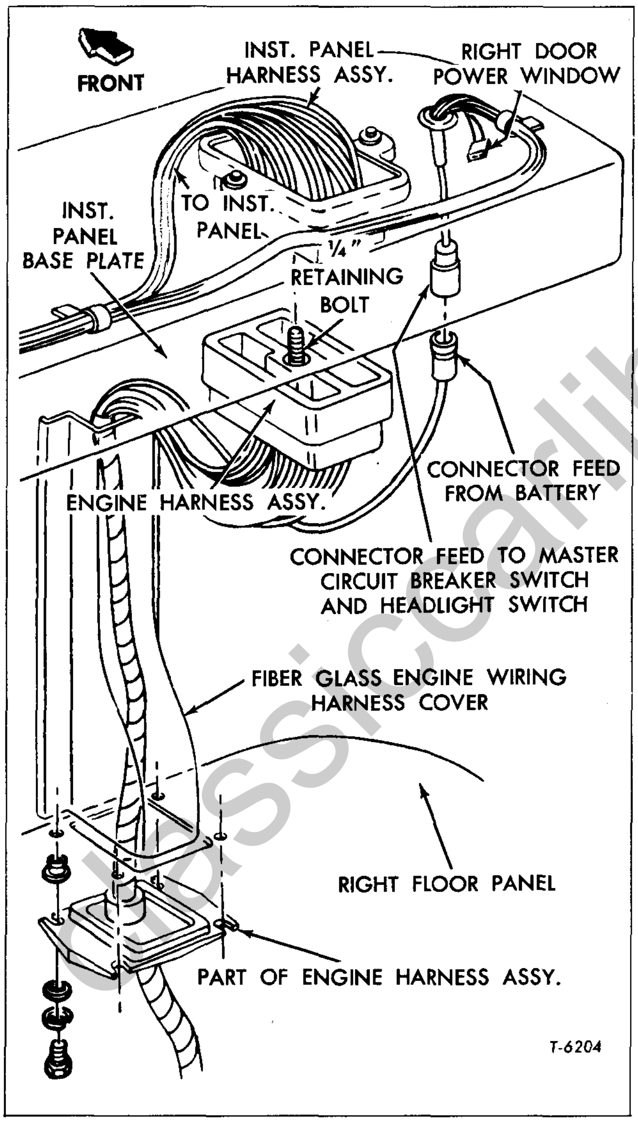


Figure 3—Engine Harness to Instrument Panel Harness Connector (Alum. Tilt Cab Models)

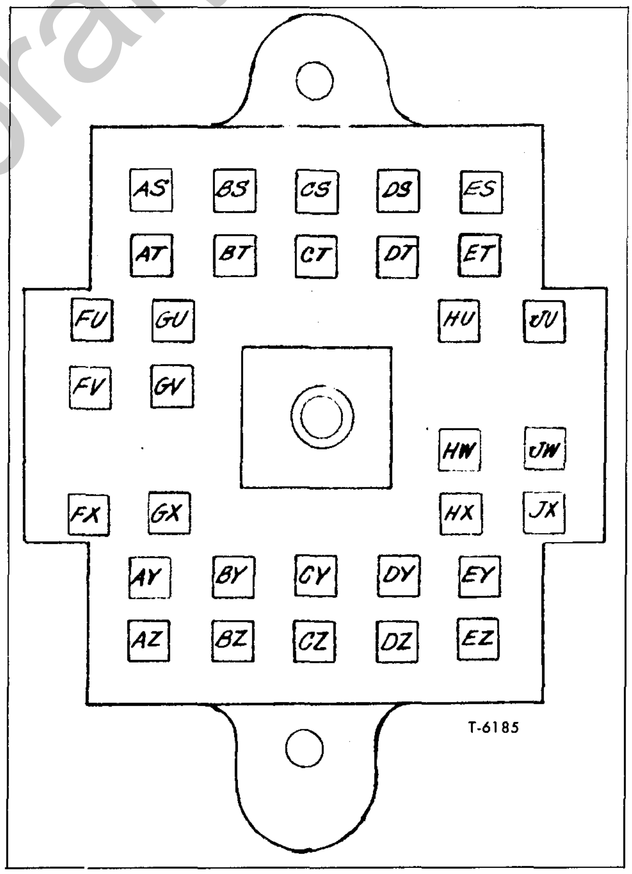


Figure 4—Engine Wiring Harness Connector Terminal Identification (Alum. Tilt Cab Models)

IMPORTANT: Mating connectors must be assembled straight and slowly to assure proper alignment of terminals. Tighten bolt slowly to approximately 60-inch pounds torque. While bolt is being tightened, check to be sure gap between connectors is uniform.

5. Assemble connector with index rib and groove aligned.

6. After bolt is tightened, visually inspect connection to be sure no terminals have been pushed out of the connector.

7. Install two screws to attach the connector to instrument panel, if removed.

8. Position fiberglass engine wiring harness cover over wiring harness and attach with six screws.

9. Install windshield washer container on dash panel.

INSTRUMENT PANEL HARNESS TO ENGINE HARNESS CONNECTOR (SYMBOL □)
(TRUCK MODEL 9502)

Terminal Letter	Circuit	Wire Size	Color Code
AS	OPEN		
AT	LOW COOLANT INDICATOR		
	Instrument Panel Harness to Coolant Loss Indicator 3-Way Connector	16	Yell.
	Low Coolant Probe	16	Blk.
AY	ENGINE ALARM		
	Engine Alarm Buzzer and Low Air Tell-Tale	16	Blk. Grn. Tr.
	Low Air Switch	16	Blk.
AZ	ENGINE ALARM		
	Low Oil Switch	16	Blk.
	Engine Alarm Buzzer and Low Oil Tell-Tale	16	Yell. // Blue Tr.
BS	OPEN		
BT	2-SPEED AXLE		
	Air Pressure Switch - Speedometer Adapter	16	Blk.
BY	STARTER SWITCH		
	From Start Switch	16	Maroon
	Auxiliary Start Switch and Starter Magnetic Switch	16	Blk.
BZ	JACOBS ENGINE BRAKE		
	Clutch Switch - Micro Buffer Switch	16	Blk.
CS	AIR CONDITIONING		
	A/ C Switch "ON"	16	Grn.
	A/C Compressor and Clutch	16	Blk.
CT	DIRECTIONAL AND HAZARD WARNING		
	Instrument Panel Harness to Directional and Hazard Warning Switch Harness 8-Way Connector	16	Grn.
	R.H. Stop, Tail and Directional Lamp 4-Way Connector	16	Blk.
CY	LIGHTING		
	Dimmer Switch "LO"	16	Brn. Wht. Cr. Tr.
	R.H. Headlamp Connector	16	Blk.
CZ	GAUGES		
	Water Temperature Sender	16	Blk.
	Water Temperature Gauge	16	Grn. Blk. Tr.
DS	I.C.C. MARKER LAMPS		
	Instrument Panel Harness to Trailer Cable Jct. 5	16	Blk.
	I.C.C. Marker Lamps	14	Blk.
DT	STOP, TAIL AND DIRECTIONAL LAMPS		
	Instrument Panel Harness to Directional and Hazard Warning Switch 8-Way Connector	16	Yell.
	Engine Harness to Stop, Tail and Back-up Lamp 4-Way Connector	16	Blk.
DY	GAUGES		
	Oil Pressure Sender	16	Blk.
	Oil Pressure Gauge	16	Blue
DZ	GAUGES		
	Fuel Gauge Tank Unit	16	Blk.
	Fuel Gauge	16	Brn. Wht. Cr. Tr.
ES	MARKER LAMPS		
	Instrument Panel Harness to Trailer Cable Jct. 1	16	Brn.
	Engine Harness to Stop, Tail and Back-up Lamp 4-Way Connector	16	Blk.
ET	GAUGES		
	Oil Temperature Sender	16	Blk.
	Engine Oil Temperature Gauge	16	Red, Blk. Tr.
EY	ENGINE ALARM		
	Hot Engine Switch	16	Blk.
	Spliced Connector to Engine Alarm Buzzer and Low Water Tell-tale	16	Grn. Wht. Tr.

INSTRUMENT PANEL HARNESS TO ENGINE HARNESS CONNECTOR (SYMBOL □) (CONT'D.)

Terminal Letter	Circuit	Wire Size	Color Code
EZ	STARTER SWITCH		
	From Accessory Bus Bar No. 8 Circuit Breaker	16	Wht. // Red, Tr.
	To Spliced Connector to Air Pressure Switch, Auxiliary Start Switch, and Back-up Lamp Switch	16	Blk.
FU	SPARE		
	Engine Harness Spare Wire Jct. 3 to Jct. 4	16	Blk.
FV	SPARE		
	Engine Harness Spare Wire Jct. 1 to Jct. 2	16	Blk.
FX	LIGHTING		
	Spliced Connector From Dimmer Switch "HI"	14	Grn. Wht. Cr. Tr.
	R.H. Headlamp Connector	14	Blk.
GU	SPARE		
	Engine Harness Spare Wire Jct. 2 to Jct. 3	16	Blk.
GV	SPARE		
	To Engine Harness Spare Wire Jct. 1	16	Blk.
GX	GENERATOR		
	Engine Harness to Generator Harness 4-Way Connector	16	Blk.
	Instrument Panel Harness to Coolant Loss Indicator Harness - 3-Way Connector	16	Grn.
HU	AMMETER		
	Ammeter	16	Blk. Wht. Tr.
	To 30-Amp Fuse	14	Blk.
HW	LIGHTING		
	Spliced Connector From Light Switch Terminal 7	16	Maroon
	R.H. Directional and Parking Lamp	16	Blk.
HX	TRAILER CABLE		
	Instrument Panel Harness to Trailer Cable Jct. 3	16	Grn.
	R.H. Directional and Parking Lamp	16	Blk.
JU	AMMETER		
	From 30-Amp Line Fuse to Ammeter	14	Blk.
JW	OPEN		
JX	HORN		
	From Horn Relay	14	Grn.
	To Horn	14	Blk.

CHASSIS JUNCTIONS

Terminal posts on junction blocks are numbered to correspond with numbers shown in symbols on applicable wiring diagrams.

CONVENTIONAL CAB MODELS

The chassis junction block (fig. 5) is located on right-hand side panel between the door pillar and back of cab. The junction block cover must be removed for access to junction terminals.

NOTE: On some models, the wiring junctions are made by use of mating connectors.

Refer to applicable wiring diagrams for arrangement of wiring.

STEEL TILT CAB MODELS

Chassis junction block (fig. 6) is located under left-hand step riser panel and is accessible when left door is open and cover is removed. Two 12-terminal junction blocks are used.

The junction block is used to complete electrical circuit to the instrument panel harness, the engine wiring harness, the dome lamp, and the trailer wiring harness assembly.

ALUM TILT CAB MODELS

A six terminal post junction block is located on the electrical equipment panel in the console compartment (fig. 7). Junction block is accessible after removing access cover from rear of console.

NOTE: A schematic wiring diagram is located on rear side of the access panel cover. Control panel wiring identification is shown in figure 8.

On vehicles equipped with the optional battery box heater, a five post junction block is mounted on the left side of the radiator shroud.

CIRCUIT BREAKERS

The headlight and parking light circuits on all vehicles are protected by a 25 amp automatic reset

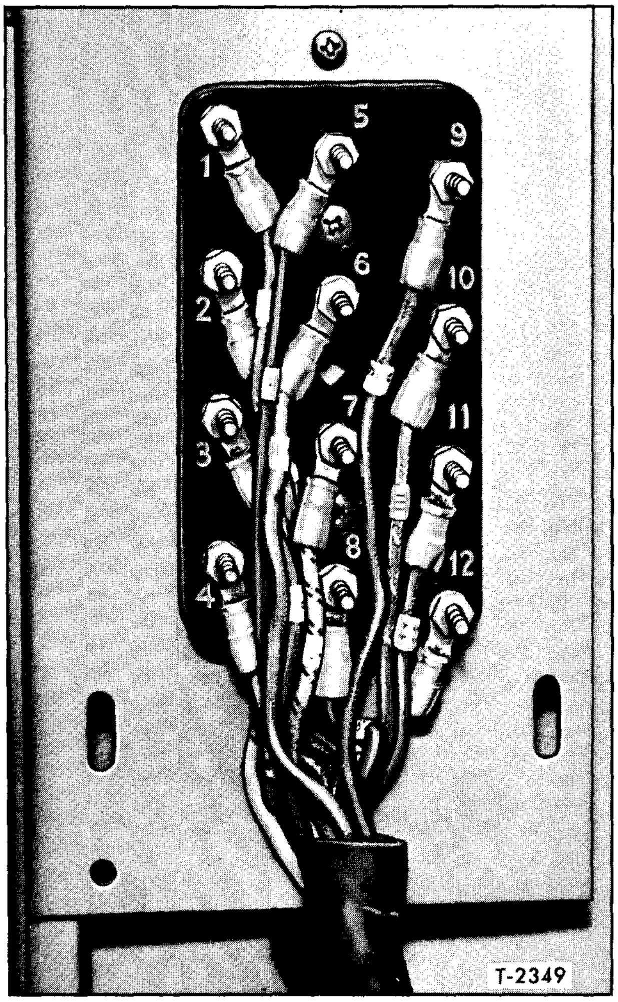


Figure 5—Chassis Junction (Conv. Cab Models) (Typical)

type circuit breaker built into the main light switch. Any condition which causes an overload on either circuit causes the bimetallic element to open the circuit. When element cools, the circuit breaker will close the circuit. This off-and-on cycle will repeat until the light switch is turned off or until the cause of overload has been located and corrected. Circuit breaker is shown in main light switch schematic wiring diagram (fig. 30, 31, or 32). If circuit breaker becomes inoperative, the light switch assembly must be replaced.

On Alum. Tilt cab models, a 70-amp manual re-set type master circuit breaker, located on the instrument panel, will de-energize the entire electrical system with the exception of the head-lamp circuit.

IMPORTANT: Do not operate vehicle longer than necessary if master circuit breaker opens. When circuit breaker rating has been exceeded, circuit breaker must be manually re-set to energize the electrical system.

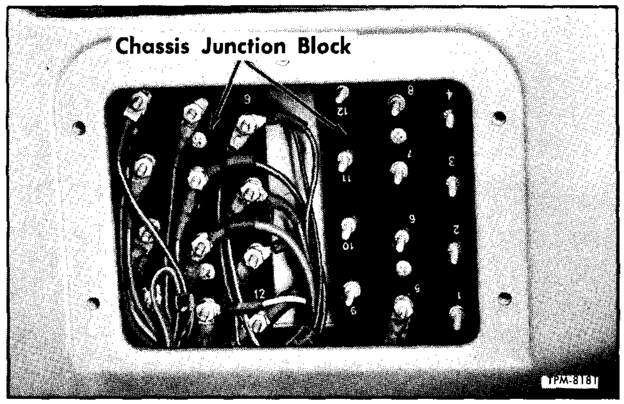


Figure 6—Chassis Junctions (Tilt Cab Models—70-80 Series) (Typical)

If electrical repairs are required on Alum Tilt vehicles, disconnect battery or pull reset button out to break circuits to prevent danger of shorting. A white ring around base of the button is visible when circuit breaker is open. The circuits are de-energized when an overload condition exists, or when the button is pulled out.

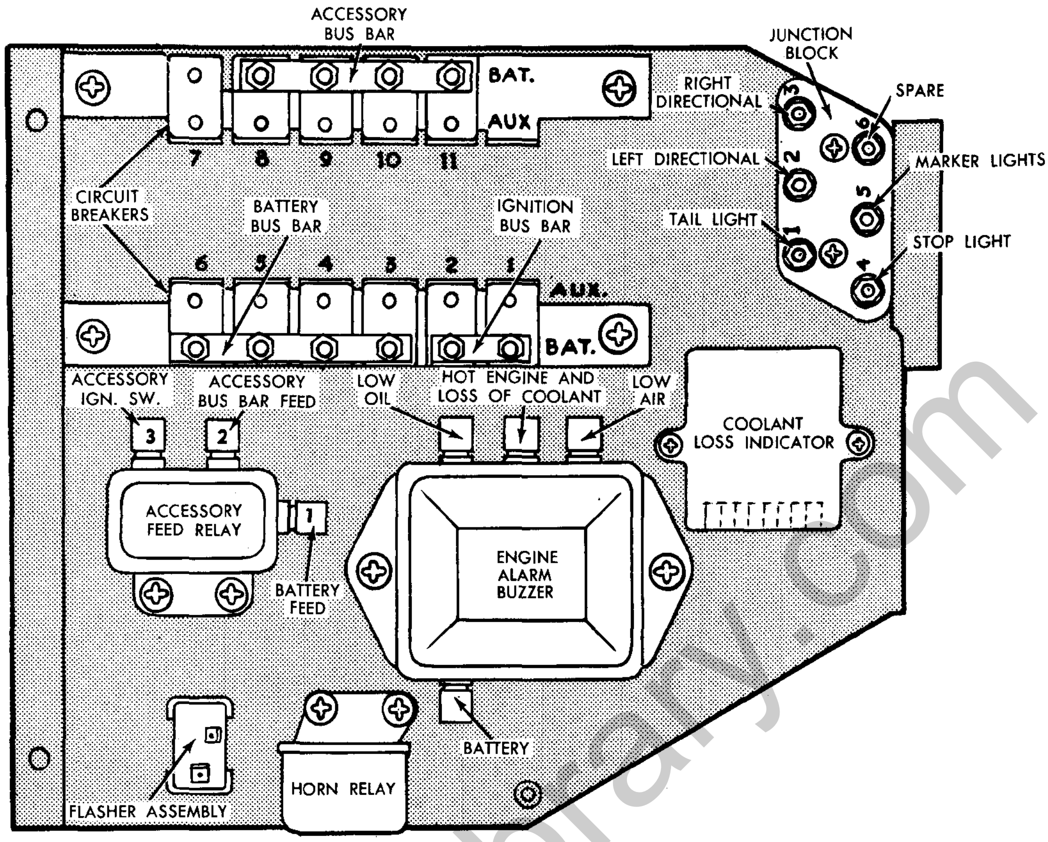
A 30-amp automatic reset type circuit breaker fed from the battery bus bar is used in the air conditioning circuit and a 20-amp automatic reset type circuit breaker fed from the accessory bus bar is used in the 2-speed axle shift switch circuit.

Any condition which causes an overload on a circuit, such as a short, will cause the automatic reset type circuit breaker bimetallic element to open the circuit; when element cools, circuit breaker will again close the circuit. This off-and-on cycle will repeat until the switch controlling the defective circuit is turned off, or until the cause of the overload has been located and corrected. In the event a circuit breaker becomes inoperative (burns out or sticks closed), the defective circuit breaker must be replaced. Circuit breakers must be installed so the feed on battery wire is connected to the "BAT" or short terminal and the wires carrying the circuit to the unit is connected to the "AUX" or long terminal.

FUSE BLOCKS AND FUSES

A bulkhead fuse panel provides power take-offs and fuse clips for appropriate circuits. The engine wiring harness connectors are bolted to the fuse panel.

Fuse and circuit breaker block on conventional cab models is located behind the dash compartment door. On Series 70 through 80 tilt cab models the fuse block is located under left end of dash panel.



Circuit Breaker No.	Amp.	Circuits
1	10	Oil Pressure Gauge and Sender, Water Temperature Gauge and Sender, Fuel Gauge and Sender, Engine Oil Temperature Gauge and Sender, Tachograph RPM and MPH Engine Alarm Buzzer, Starter, Switch, and Low Coolant Indicator.
2	15	Stop Lamp and Air Stop Switch (Includes Trailer).
3	5	Dome Lamp Circuit and Voltmeter.
4	15	Tail Lamp (Includes Trailer).
5	20	Marker Lamp.
6	20	Turn Signal and Hazard Warning.
7 (Check 4 Also)	5	Instrument Lamp Bulbs (Speedometer, Oil Temperature Gauge, Air Restrictor Gauge, Brake Air Gauge, Ammeter, Tachometer, Voltmeter, Oil Pressure Gauge, Air Gauge, Fuel Gauge, and Water Temperature Gauge).
8	30	Heater Blower, Auxiliary Starter, Back-up Lamp, Air Pressure Switch, Air Conditioning, 2- or 3-Speed Axle, and Speedometer Adapter.
9	5	Differential Lock Switch and Tell-tale, Low Water Tell-tale, Low Air Tell-tale and Switch, Low Oil Tell-tale, and Low Coolant Indicator.
10	8	Engine Brake.
11	30	Power Window (R.H.).
Master	70	All Except Headlamp.

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Figure 7—Circuit Breaker and Junction Panel (Tilt Cab Models—Alum. Tilt)

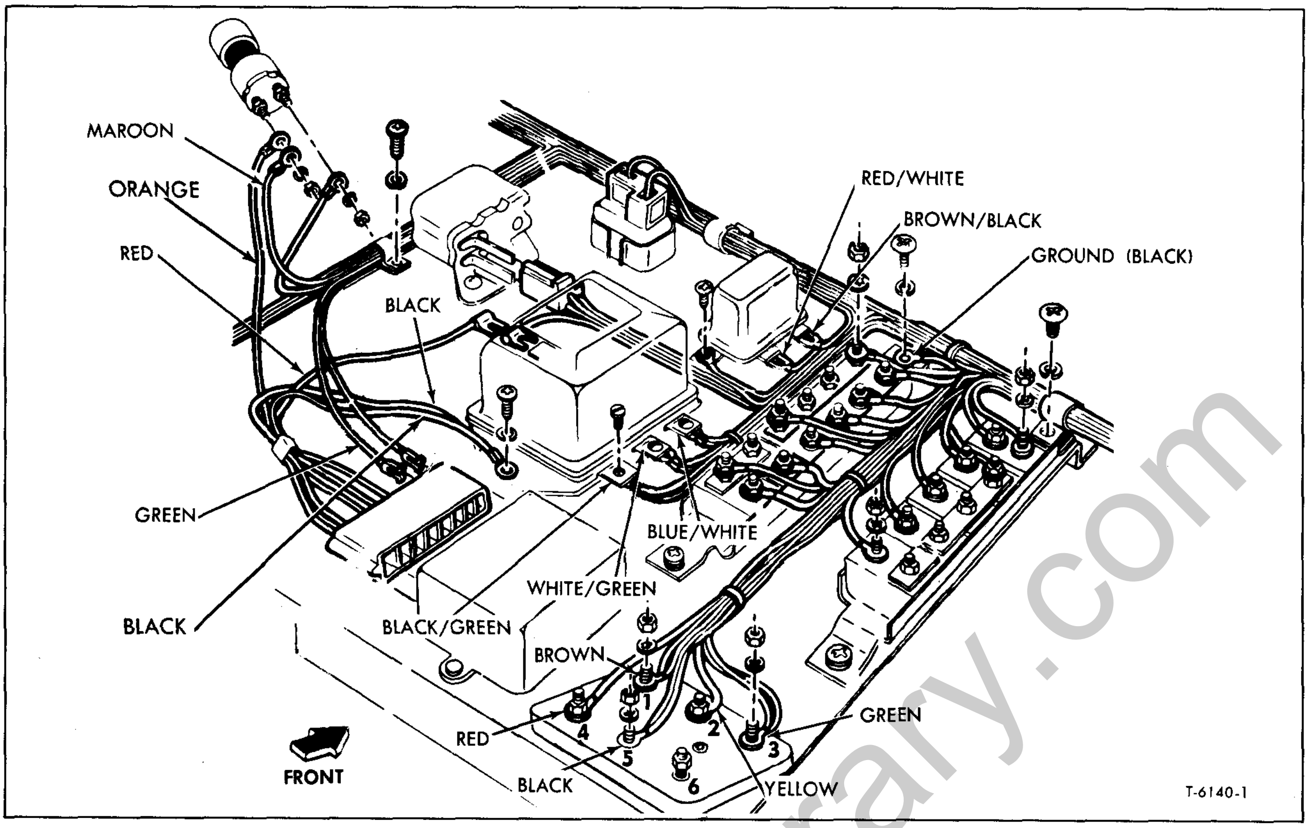


Figure 8—Control Panel Wiring Identification (Alum. Tilt Cab Models)

Two 4-amp fuses are used to protect the ammeter on conventional and steel tilt cab models. These fuses are located on fire wall near the fusible link (fig. 11) on conventional cab models.

NOTE: On Alum. Tilt cab models, two 30-amp fuses are used to protect the ammeter.

A typical fuse block used on conventional cab models is shown in figure 9. A typical fuse block used on Series 70 through 80 tilt cab models is shown in figure 10.

FUSIBLE LINKS

On conventional cab models, one replaceable fusible link is connected into the major wiring harness feed circuits (fig. 11). The fusible link is incorporated as part of the wiring system to provide increased overload protection to electrical circuits, except the starting motor circuit, which are not otherwise protected by fuses or circuit breakers.

The fusible link is a wire of four gauge sizes smaller than the smallest feed wire; for example: A fusible link of 16 gauge wire must have 12 gauge wire or larger in all unprotected circuits of the link system. To aid in identification, the gauge size of the wire is labeled on the side of the link.

IMPORTANT: If an overload or some other condition destroys a link, locate and correct the

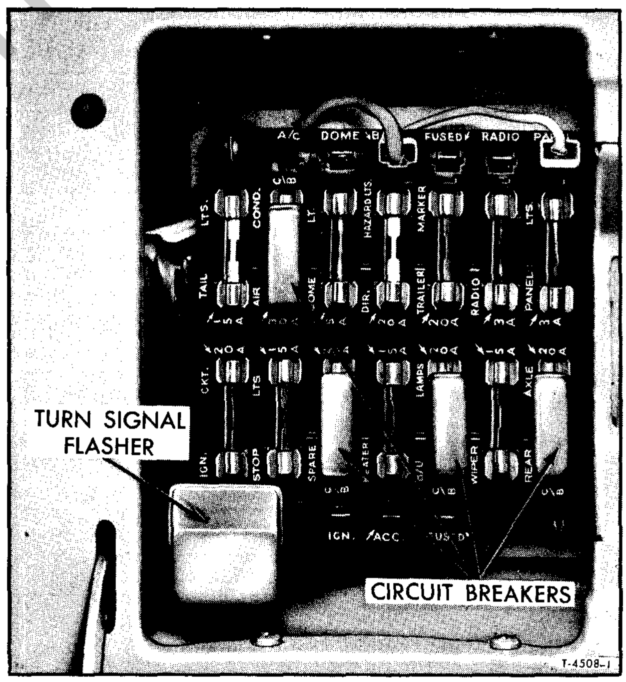


Figure 9 —Fuse Block and Circuit Breaker Mounting (Conv. Cab Models) (Typical)

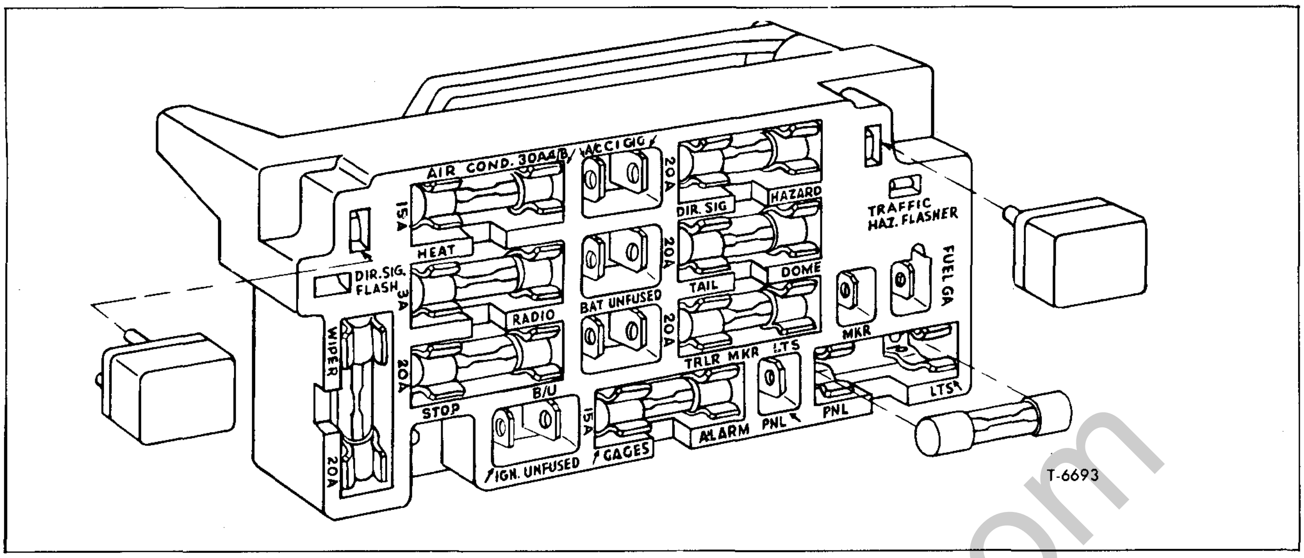


Figure 10—Fuse Block and Circuit Breaker Mounting (Tilt Cab Models)

cause of the failure, then replace the link with a wire of the same gauge size and length. DO NOT replace a fusible link with a wire of larger size. Refer to Master Parts Book for correct replacement part number.

MECHANICAL SPEEDOMETER

Speedometer is mechanically driven from speedometer adapter by a flexible cable. The miles-per-hour hand is magnetic cup actuated, while the odometer is direct gear actuated. If speedometer becomes inoperative, disconnect cable at rear of speedometer head and adapter and check to make sure cable and drive gear on transmission are operating properly. This can be done by driving vehicle forward while an assistant checks movement of the drive cable inside the flexible cable.

If the drive cable and drive gear appear to be operating properly, repair or replace the speedometer head. Replace the cable if kinked or broken. If the speedometer head, adapter and cable are operating properly, replace the speedometer drive gear.

To check speedometer for accuracy, use a test machine that is equipped with a drive. Connect

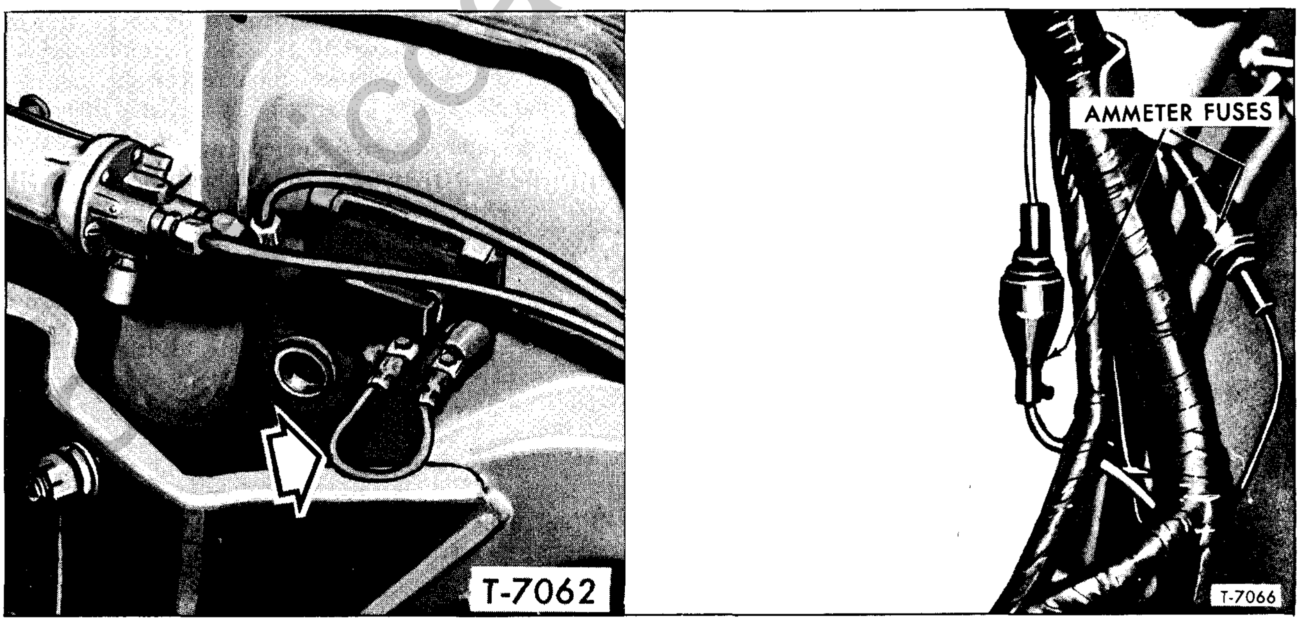


Figure 11—Fusible Link and Ammeter Fuses (Typical)

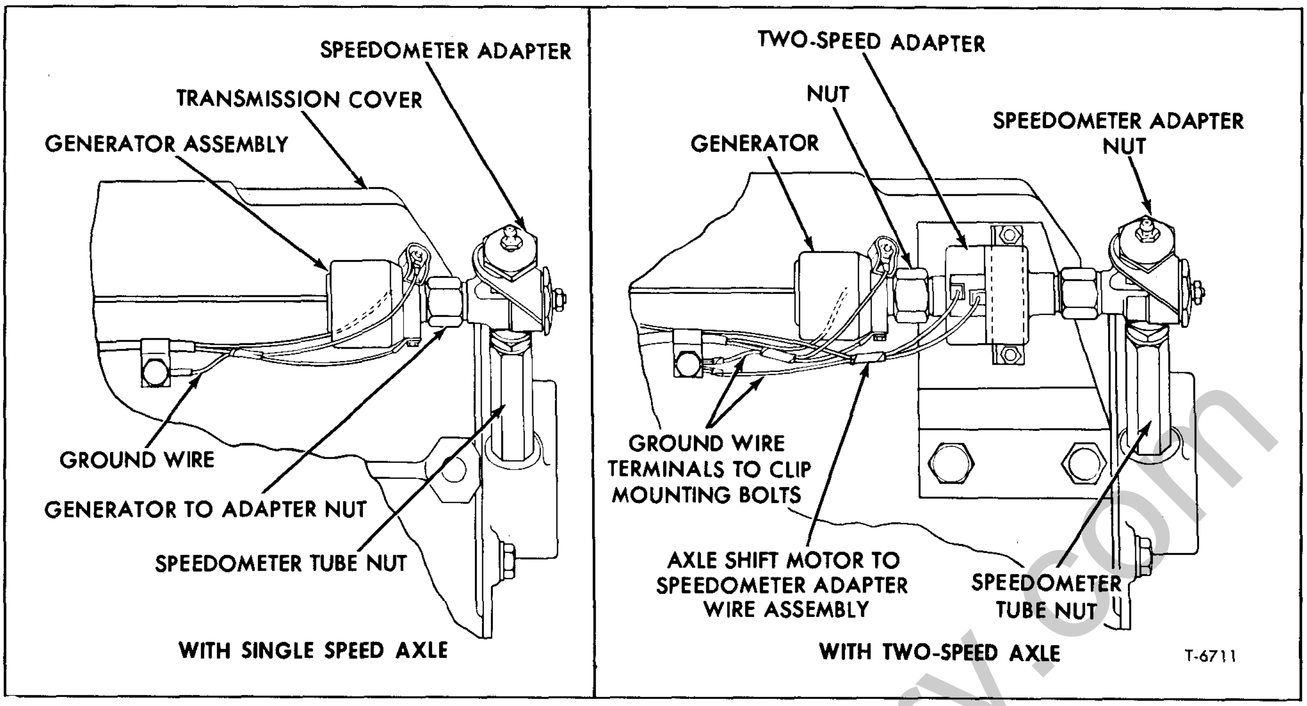


Figure 12—Electric Speedometer Drive Connections at Transmission

speedometer head to drive and operate at a known 1000 rpm. The miles-per-hour hand should register 60 mph and the odometer should register one mile-per-minute. If not, speedometer head is defective and must be replaced.

NOTE: On vehicles equipped with the front wheel speedometer drive, refer to "FRONT AXLE" (SEC. 3B) of this manual for speedometer drive components.

SPEEDOMETER CABLE REPLACEMENT AND LUBRICATION

1. Disconnect speedometer cable from speedometer head.
2. Remove cable by pulling it out of speedometer end of conduit.

NOTE: If cable is broken, it will be necessary to remove lower portion of cable from transmission end of conduit.

3. Lubricate lower ¾ of cable with lubricant specified in LUBRICATION (SEC. 0) of this manual, then push cable into conduit. Connect upper end of cable to speedometer head and road test vehicle for proper speedometer operation.

CAUTION: DO NOT over-lubricate the flexible cable or adapter. Excessive lubrication will seriously affect speedometer operation.

ELECTRIC SPEEDOMETER

A permanent magnet AC generator (sending unit) is mounted on the speedometer adapter at rear of transmission (fig. 12) and is driven by the transmission output shaft. The generator supplies a signal whose amplitude is proportional to its driven speed. This signal is rectified to direct current (D.C.), smoothed and fed to meter movement of the speedometer, mounted on the instrument panel, where it is read in miles-per-hour.

The generator also incorporates a set of non-replaceable breaker points, which operate a stepping motor that drives the odometer worm gear mechanism at regular mileage intervals.

Refer to applicable wiring diagram for electrical circuits and connections.

NOTE: On vehicles equipped with the optional 2-speed axle, the sending unit is mounted on the 2-speed axle shift switch adapter.

MAINTENANCE

The following procedures for disassembly, testing, assembly, and calibration of speedometer system are made after units are removed from the vehicle. Remove speedometer from instrument panel by disconnecting wiring from the unit, then remove nuts and washers which attach speedometer to instrument panel and bracket. Disconnect wiring from terminals on sending unit, then remove sending unit from speedometer or axle shift switch adapter.

TOOLS AND EQUIPMENT

Electrical equipment and small hand tools required for diagnosis are listed below:

NOTE: Defective speedometers or generators are serviced by replacement. To assist in determining which unit is defective, refer to the "Trouble Diagnosis Chart" later.

1. Simpson 160 or 260 Multimeter or equivalent.
2. Small hand tools such as:
   a. No. 10 and 12 nut driver.
   b. 1-1/16" open-end wrench.
   c. Medium blade screwdriver.

ELECTRIC HORN

The electric air-tone "S" type horn is carefully adjusted and inspected during manufacture and should operate indefinitely without attention. The horn assembly should not be adjusted or repaired.

If the horn fails to operate, use a jumper lead to check the external horn circuit as follows:

1. Connect jumper lead from No. 2 terminal on horn relay to ground. If horn then operates, the trouble is in the horn control circuit. If horn does not operate remove jumper lead and proceed with Step 2.
2. Momentarily connect jumper lead between No. 3 and No. 1 terminals on horn relay. If horn operates, the relay is defective.
3. Horn circuit is internally grounded through the horn mounting. Therefore, it is necessary that a good ground connection be maintained between the horn mounting bracket and its mating part. Check for a good ground by connecting a jumper lead from the horn bracket to the vehicle frame or grounded side of battery. Be sure contact is made through the paint of the horn bracket and frame.

If trouble was not corrected by the above checks, a foreign particle may be holding the horn contacts open. This condition can sometimes be corrected by energizing the horn, then lightly tapping the horn power plant to dislodge the particle. If this fails to correct the problem, replace the horn assembly.

AIR HORN

Air horns, used as standard or optional equipment on some models, are mounted on pedestals attached to the cab roof panel. Air pressure to horns is controlled by a control valve mounted on the inner hinge pillar panel at left side of cab. A signal cord is used to manually activate the control valve.

Air pressure is supplied by the pressure protection valve. Refer to "AIR BRAKES" (SEC. 5B) of this manual for information on the pressure protection valve.

If the air horn control valve becomes inoperative, a service kit consisting of a spring, rubber seat, and plunger may be installed after disconnecting the air inlet line and removing end plug from valve.

RELAYS

Relays are used in some instances to automatically open or close a circuit as operating conditions may require; in other cases, they are used to provide a direct connection between the battery and an electrically operated device, with only a small amount of current required to energize the relay operating coil. The latter use eliminates the use to great lengths of heavy wire, thereby providing higher voltage to the electrical device.

NOTE: Information pertaining to the Frequency Sensing Relay used on Alum Tilt vehicles is covered under "INTEGRAL TYPE ALTERNATING CURRENT GENERATING SYSTEM" in ENGINE ELECTRICAL (SEC. 6Y) of this manual.

Information pertaining to the Starter Magnetic Switch and Starter Interlock Relay is covered under "STARTING SYSTEM" in ENGINE ELECTRICAL (SEC. 6Y) of this manual.

ACCESSORY FEED RELAY

The accessory feed relay, used on Alum Tilt cab models, is located on the circuit breaker and junction panel located behind the gauge panel under the console as shown in figure 7.

A schematic diagram of this relay is shown in figure 13. Relay terminal No. 1 is fed from the battery bus bar through the 70-amp master circuit

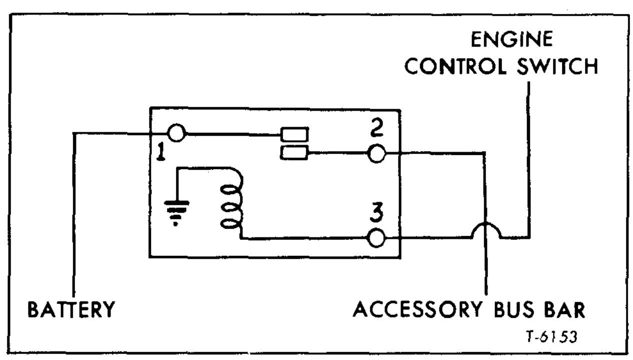
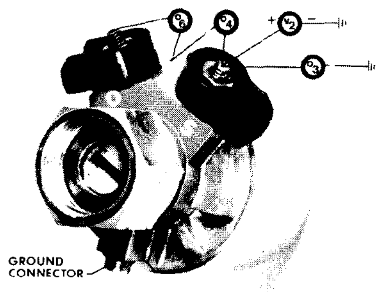
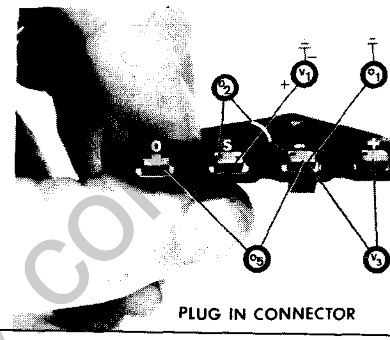


Figure 13—Accessory Feed Relay Schematic Diagram (Alum. Tilt Cab Models)

AC Electric Speedometer
Quick Check Procedure



GENERATOR



PLUG IN CONNECTOR

Inoperative System

Disconnect plug-in connector at rear of speedometer.

Connect ohmmeter between "-" terminal of connector and ground (Test O_1).

If infinity is shown, repair open ground circuit.
If continuity is shown, proceed to next step.

Connect voltmeter to "S" terminal of connector and ground (Test V_1) switch voltmeter to AC scale. Operate vehicle at an estimated 10 m.p.h.

If a steady voltage indication of approximately 1-1/2 volts is indicated, replace defective speedometer.

If no voltage is indicated, proceed to next step.

Disconnect wire at "S" terminal of generator. Connect voltmeter to this terminal. Lift rear wheels (Test V_2) and operate vehicle at an estimated 10 m.p.h.

If no voltage is shown, generator drive key may be broken or disengaged. Make visual check; replace if required and repeat Test V_2.

If no voltage is indicated, replace generator.

If a voltage indication of approximately 1-1/2 volts is shown, repair or replace defective lead-in wire.

Inoperative Speedometer (Odometer Functional)

Disconnect plug-in connector at rear of speedometer.

Connect ohmmeter between "S" and "-" connectors. (Test 0_2).

If an indication of 45 ± 5 ohms is shown, replace defective speedometer.

If an open or short is indicated, go to next step.

Disconnect wire at "S" terminal of generator. Connect ohmmeter between generator "S" terminal and ground (Test 0_3).

An indication of 45 ± 5 ohms indicates that the generator is OK. Therefore, repair or replace defective lead-in wire.

If an open or short is indicated, connect ohmmeter between generator "S" terminal and generator casting (Test 0_4).

If an open or short is indicated, replace generator.

Inoperative Odometer (Speedometer Functional)

Disconnect plug-in connector at rear of speedometer. Switch voltmeter to DC scale and connect it between "+" and "-" terminals on connector. (Test V_3). If zero, repair open battery circuit; if between 10 and 16 volts, proceed with next step.

Connect ohmmeter between "0" and "-" connector at rear of speedometer. Operate vehicle a minimum of 100 ft. or lift rear wheels and operate for this distance. (Test 0_5).

When the odometer contacts within the generator are closed, the indicated resistance should not exceed 20 ohms. When the contacts are open, infinity shall be indicated. The contacts will go through one cycle in 100 ft., and while in the "closed point" condition, will not behave erratically resistance-wise.

If Test 0_5 does not meet requirements, disconnect wire at "0" terminal of generator. Connect ohmmeter between "0" terminal of generator and generator casting, and repeat outlined procedure in Test 0_5. (Test 0_6).

If Test 0_5 meets requirements, replace defective speedometer.

If Test 0_5 requirements are not satisfied, replace generator.

If Test 0_5 requirements are satisfied, repair or replace defective lead-in wire.

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breaker. Relay operating coil terminal No. 3 is fed from the "ACC" position of the control switch when switch is in "IGN" or "ACC" position. When relay operating coil is energized, contacts close to complete circuit from battery to accessory bus bar and circuit breakers 8, 9, 10 and 11 shown in figure 7.

GENERATOR TELL-TALE RELAY (WHEN USED)

The generator tell-tale relay is used on some vehicles to control the circuit to the generator no-charge tell-tale lamp.

Relay terminal No. 1 is fed through a 15-amp fuse on the ignition bus bar when engine control switch is in "IGN" position. When control switch is placed in "IGN" position, current from the battery will flow through the generator tell-tale lamp and relay terminal No. 1 to ground through terminal No. 2. When engine is started, current from generator "R" terminal will flow through relay operating coil windings (terminal No. 3) causing contact points to open, thus breaking the circuit to the tell-tale lamp.

Relay is non-adjustable or repairable, therefore if it becomes inoperative, replace.

HORN RELAY

Refer to applicable wiring diagram for wiring connections at horn relay.

Horn button in center of steering wheel is connected in series with the relay operating coil at relay terminal No. 2. When circuit through relay operating coil is completed at the horn button, a small amount of current flows from the battery through the coil winding. With winding energized, armature is attracted to core and points close. Current from the battery (No. 1 terminal) then flows directly through relay contacts and out No. 3 terminal to the horn. The relay thus provides a higher voltage to the horn by avoiding voltage drop through the long circuit through the horn button. The relay is non-adjustable or repairable, therefore if it becomes inoperative, replace.

TRAILER I.C.C. MARKER LAMP RELAY (WHEN USED)

The trailer I.C.C. marker lamp relay is mounted on the junction block at right rear of cab on conventional cab models and on the steering column support on series 70 through 80 tilt cab models. Refer to applicable wiring diagram in "Wiring Diagrams" booklet for wiring connections at relay.

The marker lamp switch on instrument panel is connected in series with main light switch and operating coil of I.C.C. marker lamp relay operating coil at terminal No. 3.

When the main light switch and the marker lamp switch are placed in "ON" position, a small amount of current will flow through the relay coil winding. With winding energized, armature is attracted to core and points close. Current from the battery (No. 1 terminal) then flows directly through relay contacts and out terminal No. 2 to complete circuit to rear I.C.C. marker lamps.

If opening voltage is not within limits listed in "Specifications" at end of this section, replace the relay.

HEATER AND RADIO PANEL (ALUM. TILT CAB)

IMPORTANT: Before removing the heater and radio panel located in the console to right of driver, disconnect negative cable(s) from the battery to prevent accidental shorting.

1. Remove screws which attach access panel to rear of console, then remove access panel.
2. Remove six screws which attach heater and radio panel to console, then lift panel up out of console enough to remove attaching wires and linkage from under panel and through access panel opening. Remove knobs as necessary to remove switches and controls from access panel.
3. Position switches and controls on panel and connect wiring to switches.
4. Position panel in console and install screws to attach.
5. Install access panel to rear of console, then connect negative battery cable(s) to battery and check operation of each unit.

STARTER SWITCH

On conventional cab models and Series 70-80 tilt cab models the ignition or control switch is mounted on the dash panel. The starting circuit is energized by placing the switch in "START" position. For information relative to replacing this switch, refer to "Ignition Switch Replacement" under "IGNITION SYSTEM" in ENGINE ELECTRICAL (SEC. 6Y) of this manual.

The alum tilt cab models are equipped with two momentary-on push button-type starter switches. The switch mounted on the console below the gauge panel can be energized only when the engine control switch is in the "IGN" position. The auxiliary start switch is located inside the left frame rail and is protected by a rubber boot. This switch is fed through the No. 8 circuit breaker when the engine control switch is in the "ACC" or "IGN" position.

ENGINE CONTROL SWITCH REPLACEMENT

The control switch and harness-to-switch connector features a three tang lock to secure a firm connection. The switch lock cylinder and cylinder housing can be replaced as follows:

REMOVAL

1. On conventional cab and Series 70-80 tilt cab models, disconnect negative battery cable from battery. On series alum tilt cab models, pull master circuit breaker re-set button on console out until the white ring around base of button is visible.
2. Remove lock cylinder by positioning switch in "OFF" position, then inserting wire into small hole in cylinder face. Push in on wire to depress plunger and continue to turn key counterclockwise until lock cylinder can be pulled from cylinder housing.
3. On conventional cab and Series 70-80 tilt cab models, remove screws which attach instrument cluster to dash panel. On alum tilt cab models, remove panel access cover.
4. Remove ignition switch retaining nut from dash panel.
5. On conventional cab and Series 70-80 tilt cab models, tilt cluster outward and pull control switch from panel opening, then separate wiring connectors by inserting a thin bladed screwdriver under each tang of the wiring connector. Pull connector from switch.

On alum tilt cab models, reach through access panel opening and remove control switch from console. Separate wiring connectors by inserting a thin bladed screwdriver under each tang of the wiring connector. Pull connector from switch.

INSTALLATION

1. On conventional cab and Series 70-80 tilt cab models, tilt cluster outward and position control switch in opening. Engage lock tangs of wiring connector to switch. Make sure lock tangs are fully engaged by attempting to separate. Insert switch into panel opening, then install switch retaining nut firmly.

On alum tilt cab models, position switch through access panel opening and engage lock tangs of wiring connector to switch. Make sure connector is fully engaged by attempting to separate. Position switch into opening in console and install switch retaining nut and tighten firmly.

2. Insert switch lock cylinder in switch housing and rotate clockwise to secure in lock position.
3. Install screws which attach instrument cluster to panel, or install access panel cover.
4. Connect negative battery cable to battery, or press in on re-set button on console to energize the master circuit breaker. Check operation of control switch.

TRAILER EMERGENCY STOP LIGHT SWITCH (WHEN USED)

The air-operated emergency stop light switch is used as optional equipment on some vehicles covered by this manual. Refer to applicable wiring diagram for electrical connections at this switch. Refer to "AIR BRAKES" (SEC. 5B) of this manual for information relative to testing and replacing the switch.

POWER WINDOW SWITCH (WHEN USED)

On alum tilt cab models equipped with the optional right-hand powered window, a toggle type switch is located on the console above the heater controls. This switch controls operation of the window lift motor. The switch is fed through No. 11 circuit breaker on accessory bus bar when engine control switch is in "ACC" or "IGN" position.

NOTE: Refer to "CAB AND SLEEPER COMPARTMENT" (SEC. 1B) of this manual for service information pertaining to the right-hand door electric power window.

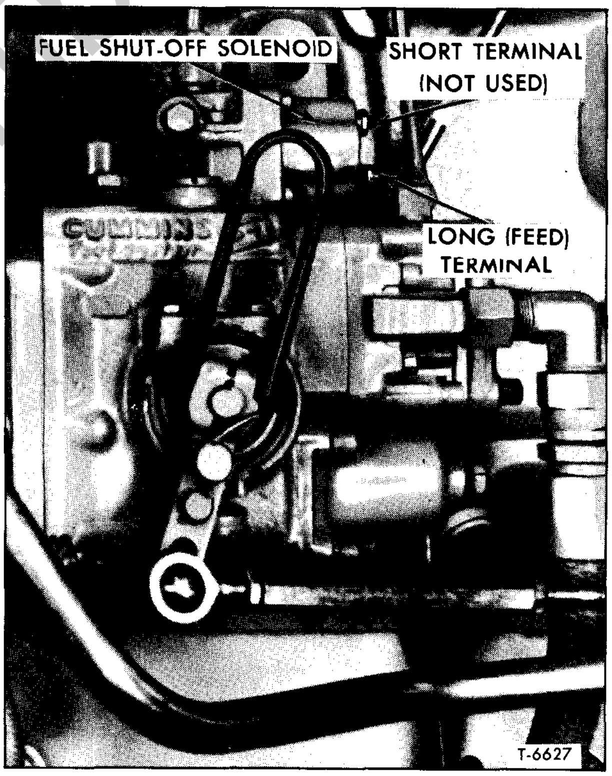


Figure 14—Fuel Shut-Off Solenoid

ENGINE BRAKE SWITCH (WHEN USED)

Three switches, connected in series, are used to operate the engine brake system. The manually-operated engine brake switch on console is fed from No. 10 circuit breaker on accessory bus bar when engine control switch and engine brake switch are in "ON" position. Also, there must be a closed circuit through switch at clutch lever and micro switch at buffer screw to supply current to solenoid valves at brake supply housings.

Refer to "Engine Brake" under "IN-VEHICLE SERVICE" in 71 SERIES DIESEL ENGINES (SEC. 6C) of this manual for information pertaining to the engine brake.

INTER-AXLE DIFFERENTIAL LOCK SWITCH

The inter-axle differential lock switch is located on the dash panel or console on vehicles equipped with the tandem rear axle. When switch lever is positioned in "LOCK" position, the "DIFF. LOCK" tell-tale lamp illuminates. Refer to "REAR AXLE AND CONTROLS" (SEC. 4A) of this manual for information relative to this unit.

FUEL SHUT-OFF SOLENOID

An engine fuel shut-off solenoid is used to control the flow of fuel to the engine. The solenoid is energized through No. 8 circuit breaker on accessory bus bar when control switch is in "IGN" or "ACC" position.

NOTE: On Series HN/JN-90, the solenoid is energized from "IGN" position of the control switch.

IMPORTANT: Feed wire to fuel shut-off solenoid must be connected to the lower (long) terminal on solenoid (fig. 14). If feed wire is connected to the upper (short) terminal, damage to wiring harnesses and control switch will result when control switch is energized.

ALARM SYSTEM

Various alarm systems are used on vehicles covered by this manual. Tell-tale lights, located on the gauge and tell-tale panel in front of driver are illuminated only when the bulb behind the lettering is illuminated.

A low vacuum, low air pressure, and/or engine alarm buzzer is used to audibly alert the driver of low vacuum, low air pressure, low oil pressure, or an overheated engine.

LOW VACUUM ALARM SYSTEM

The low vacuum alarm system, on vehicles so equipped, consists of a low vacuum switch, a buzzer, and a gauge to audibly and visually warn the driver when vacuum in the system is below a safe limit.

The low vacuum alarm buzzer is mounted on left side of dash panel inside the cab. When circuit through buzzer is completed at low vacuum switch, action of the vibrating armature striking the core produces a buzzing sound.

Low vacuum alarm system wiring connections are shown on wiring diagrams in applicable "Wiring Diagrams" booklet. The alarm buzzer and switch are not repairable units. If unit becomes inoperative, replace.

LOW AIR PRESSURE ALARM SYSTEM

The low air pressure alarm system, on vehicles so equipped, consists of a low air pressure switch, a buzzer, and a tell-tale and/or gauge to audibly and visually warn the driver when air pressure in the system is below a safe limit for brake operation. Refer to "AIR BRAKES" (SEC. 5B) of this manual for information on low air pressure switch.

The low air pressure alarm buzzer is mounted on left side of dash panel inside the cab on conventional cab models; on instrument panel to steering column support bracket on 70-80 tilt cab models; or under the console (fig. 7) on alum tilt cab models. When circuit through buzzer is completed at low air pressure switch, action of the vibrating armature striking the core produces a buzzing sound.

Low air pressure alarm system wiring connections are shown on applicable wiring diagrams. In the event of failure, the buzzer must be replaced.

NOTE: This system is part of the "Engine Alarm System" when vehicle is so equipped.

ENGINE ALARM SYSTEM

This system, used as optional equipment on some vehicles, audibly and visually warns the driver of Low Air Pressure, Low Oil Pressure, and Overheated Engine or Loss of Coolant. The alarm system consists of a low air pressure switch, low oil pressure switch, hot engine switch and/or low coolant probe, alarm buzzer and rectifier assembly, low coolant control, and a separate tell-tale light for each condition. The buzzer and rectifier assembly is mounted on left side of dash panel inside the cab on conventional cab models, on instrument panel to steering column support bracket on series 70-80 tilt cab models and on circuit breaker and junction panel under console (fig. 7) on alum tilt cab models. Wiring connections are shown on applicable wiring diagrams.

Low Coolant Probe is located in the rear top of the radiator tank and the hot engine switch is located in the thermostat housing or water manifold. For replacement, refer to ENGINE COOLING (SEC. 6K) for "Hot Engine Switch," and RADIATOR AND SURGE TANK (SEC. 13) for low coolant probe. These switches are sealed units and are not adjustable or repairable. If switch fails to function properly, replace. To check the switch, disconnect wire from the switch and ground. If tell-tale bulb fails to light, replace the switch and/or bulb.

Buzzer and rectifier assembly consists of a vibrating armature type relay which produces a buzzing sound when the circuit through relay coil is completed by either of three controlling switches and a three circuit rectifier. The rectifier permits current flow in one direction only, preventing a back flow of current from one alarm circuit from illuminating the other tell-tale lights. Thus, when only one abnormal condition exists, the buzzer will sound but only the tell-tale light connected to that circuit will illuminate.

If alarm buzzer or rectifier assembly does not operate properly, replace the complete unit.

COOLANT LOSS INDICATOR

DESCRIPTION

The low coolant indicator used as optional equipment on some vehicles will audibly and vis-

TROUBLESHOOTING COOLANT LOSS INDICATOR

Fault	Check
No light during cranking.	1. Tell-Tale Lamp defective. 2. No 9 circuit breaker open. 3. Check for +12 to 14 volts at ignition circuit bus bar (fig. 5) driver's control panel during engine cranking. 4. Defective control unit.
Low Coolant (Upper Tank Low or Empty) No Alarm or Light.	1. No. 1 circuit breaker open. 2. Probe circuit grounded to chassis. 3. Defective probe. 4. Defective control unit.
Defective Probe.	1. Disconnect wire from probe with engine operating - tell-tale and alarm should operate. NOTE: When grounding probe wire to chassis, tell-tale and alarm should shut off. This indicates that the control unit is operative. 2. Reconnect probe wire and drain surge tank. If alarm and tell-tale do not operate with engine operating this indicates a defective probe.
Tell-Tale and Alarm Operate Continuously.	1. Probe wire disconnected or broken. 2. Control unit defective.
Intermittent Tell-Tale and Alarm.	1. Coolant level low. 2. Loose probe connection. 3. Defective probe.
Tell-Tale and Alarm when Engine is Started, then both turn off after engine is run for a few minutes.	1. Low coolant at cold level. Coolant expansion covers probe. 2. Defective probe. 3. Defective control unit.

ually alert the driver when a loss of coolant occurs in the system. A tell-tale lamp will light on the instrument panel and the alarm buzzer will sound when this condition occurs during engine operation (generator producing current).

The low coolant sensing probe, mounted in the radiator upper tank will detect a loss of coolant when the level in tank is below the probe position.

OPERATION

The Hot Engine tell-tale lamp (fig. 20) will light during engine cranking indicating that the lamp and control circuit is working. The response time of this device is extremely fast and if a complete loss of coolant occurs when the engine is running the driver is warned and possibility of engine seizure due to overheating is minimized.

NOTE: A low coolant alarm occurs when the coolant level is below the probe.

MAINTENANCE

The coolant indicator (fig. 7) unit is a solid state device and requires no maintenance. The unit is self-checking during engine cranking and if the tell-tale lamp or control unit has failed it can be readily noticed. The stainless steel probe in the radiator will resist normal cooling system contamination and requires no adjustment or maintenance.

NOTE: Refer to "Troubleshooting Coolant Loss Indicator" chart on previous page.

INSTRUMENTS AND GAUGES

CONVENTIONAL CAB MODELS

NOTE: The instruments, gauges, and tell-tale lights will vary with truck models, depending upon the size of vehicle and equipment used.

A typical instrument cluster used on Series 70 conventional cab models is shown in figure 15 and a typical cluster used on Series 90 conventional cab models is shown in figure 16. Each cluster contains gauge and tell-tale lights, gauges, speedometer, and tachometer. Lettering on each tell-tale window is visible only when the light behind the tell-tale is illuminated.

The various switches and controls, located on dash panel below the cluster, are identified by decals.

REMOVAL

IMPORTANT: To prevent accidental grounding at ammeter, disconnect negative battery cable from battery before removing instrument cluster.

1. Disconnect negative battery cable from battery, then disconnect wiring harness connectors from under dash panel. Refer to figure 17 for wiring connections at rear of cluster.
2. Remove six screws which attach instrument cluster to dash panel then tilt cluster outward far enough to reach connections at rear of cluster.

NOTE: It may be necessary to disconnect the oil pressure and/or air pressure gauge lines before tilting the cluster outward.

3. Disconnect drive cables, lines, wiring connected to terminals, and illumination and tell-tale lamp bulbs from each gauge and unit.
4. Each gauge or unit is retained in the cluster by two mounting brackets. Remove wiring from connector or terminals at rear of gauge or unit, then remove nuts and washers from mounting bracket and remove gauge or unit from rear of cluster.

INSTALLATION

NOTE: Refer to figure 17 for wiring connections at rear of cluster.

1. Position each gauge or unit in cluster and install nuts and washers to attach to mounting brackets.
2. Position instrument cluster in dash panel far enough to reach through panel opening and reach the rear of each gauge and unit.
3. Connect drive cables, lines, and wiring to each gauge or unit. Insert tell-tale and illumination lamp bulbs in sockets.
4. Move instrument cluster into position in panel opening and attach to instrument panel with retaining screws. Connect wiring harness connectors under dash, then connect negative battery cable to battery.
5. Check operation of each gauge and unit.

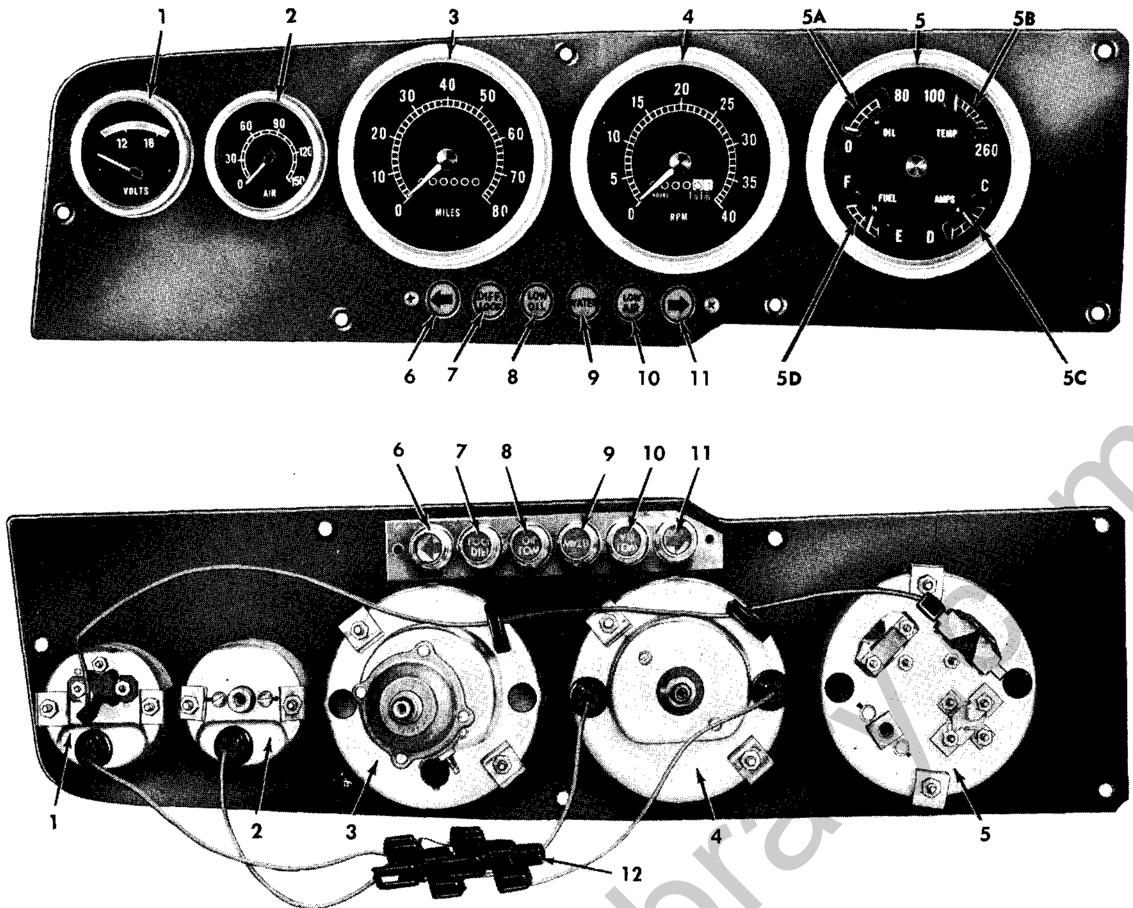
SERIES 70 THROUGH 80 TILT CAB MODELS

A typical instrument cluster used on Series 70-80 tilt cab models is shown in figure 18. Each cluster contains gauge and tell-tale lights, gauges, speedometer and tachometer. Lettering on each tell-tale window is visible only when the light behind the tell-tale is illuminated.

The various switches and controls, located on dash panel below the cluster are identified by decals.

REMOVAL

IMPORTANT: To prevent accidental grounding, disconnect negative battery cable from battery before removing the instrument cluster.



1 Voltmeter
2 Air pressure
3 Speedometer
4 Tachometer
5 Four Gauge Cluster
5a Oil Pressure Gauge
5b Engine Temperature Gauge
5c Ammeter
5d Fuel Gauge
6 L.H. Turn Signal Tell-tale
7 Differential Lock Tell-tale
8 Low Oil Tell-tale
9 Water Temp. Tell-tale
10 Low Air Tell-tale
11 R.H. Turn Signal Tell-tale
12 Wiring Connector

T-3591-1

Figure 15—Instrument Cluster (Conv. Cab Models—70-80 Series) (Typical)

1. Disconnect negative battery cable from battery, then disconnect wiring harness connectors from under dash panel. Refer to figure 18 for wiring connections at rear of cluster.

2. Remove six screws which attach instrument cluster to dash panel, then tilt cluster outward far enough to reach connections at rear of cluster.

NOTE: It may be necessary to disconnect oil and/or air pressure gauge lines before tilting the cluster outward.

3. Disconnect drive cables, lines, wiring connected to terminals, and illumination and tell-tale lamp bulbs from each gauge and unit.

4. Each gauge or unit is retained in the cluster by two mounting brackets. Remove wiring from connector or terminals at rear of gauge or unit, then remove nuts and washers from mounting bracket and remove gauge or unit from rear of cluster.

INSTALLATION

NOTE: Refer to figure 18 for wiring connections at rear of cluster.

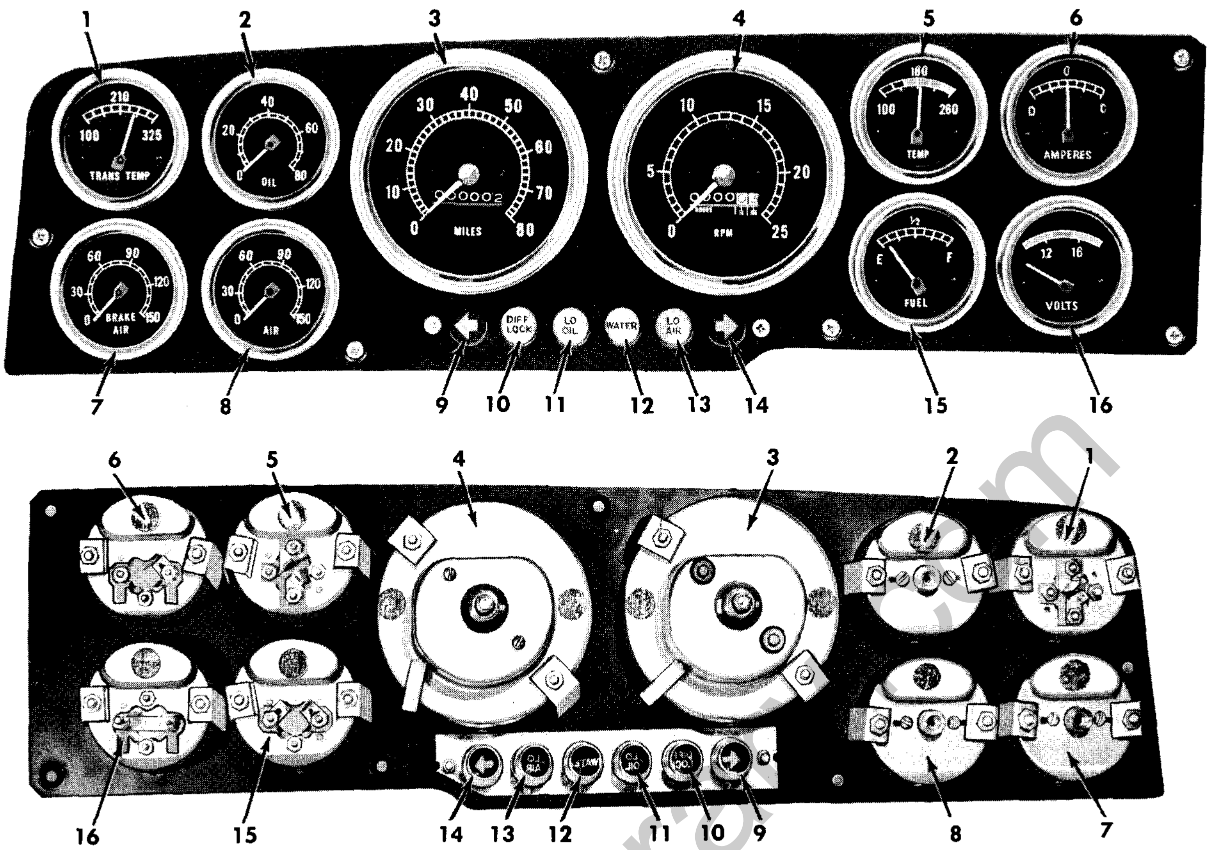
1. Position each gauge or unit in cluster and install nuts and washers to attach to mounting brackets.

2. Position instrument cluster in dash panel far enough to reach through panel opening and reach the rear of each gauge and unit.

3. Connect drive cables, lines, and wiring to each gauge and unit. Insert illumination and tell-tale lamp bulbs in sockets.

4. Move instrument cluster into position in panel opening and attach to instrument panel with retaining screws. Connect wiring harness connectors under dash, then connect negative battery cable to battery.

5. Check operation of each gauge and unit.



1 Transmission Temperature Gauge
2 Engine Oil Pressure Gauge
3 Speedometer
4 Tachometer
5 Engine Temperature Gauge
6 Ammeter
7 Brake Application Air Pressure
8 Main System Air Pressure
9 L.H. Turn Signal
10 Differential Lock Tell-tale
11 Low Oil Tell-tale
12 Water Temperature Tell-tale
13 Low Air Tell-tale
14 R.H. Turn Signal
15 Fuel Gauge
16 Voltmeter

T-2350-2

Figure 16—Instrument Cluster (Conv. Cab Models—9500 Series) (Typical)

ALUM. TILT CAB MODELS

These vehicles are equipped with gauge and tell-tale panels as shown in figure 19. Electrical connections at rear of gauge and tell-tale panels are shown in figures 20 and 21.

The tell-tale panel is located in front of driver between the speedometer and tachometer. The tell-tale panel contains a left- and right-hand directional tell-tale, differential lock tell-tale, low oil tell-tale, hot engine tell-tale and a low air tell-tale.

The gauge panel, located in console to right of driver as shown in figure 19, contains a cluster of five to nine gauges. Standard gauges include the engine temperature gauge, oil pressure gauge, voltmeter, air gauge, and fuel gauge. Optional gauges include the ammeter, air induction system restriction gauge, air brake gauge, and the engine oil temperature gauge.

NOTE: Needle position on many gauges is immaterial with the control switch in "OFF" or "ACCESSORY" position.

INSTRUMENT PANEL
GAUGE REPLACEMENT

To remove gauges shown in figure 19 from the console proceed as follows:

1. Disconnect negative battery cable from battery terminal or pull master circuit breaker switch out to prevent accidental grounding. Remove access panel as described previously under chassis junctions.

2. Remove screws which attach gauge panel to console, then tilt panel outward far enough to reach connections at back of gauges.

3. Disconnect wires and/or line from gauge. Remove retaining nuts and washers, then remove gauge and spacer from panel.

4. Position gauge and spacer in panel opening and attach to mounting clamp with nuts and washers. Tighten mounting nuts firmly.

5. Push lamp socket into gauge and connect wiring to respective terminals on gauge. Connect line to gauge (if used).

NOTE: Refer to figure 21 for wiring connections at each gauge.

6. Position gauge panel in console and attach with screws. Connect negative battery cable to battery terminal or push in on master circuit breaker to re-set.

ENGINE TEMPERATURE GAUGE

The engine temperature gauge marked "WATER TEMP." is located on the instrument or gauge panel. Efficient operating temperature range is 180°F. to 195°F. If engine overheats (215°F.), the "HOT ENG" tell-tale light will illuminate and buzzer will sound.

NOTE: The coolant loss indicator, used as optional equipment on some vehicles, is connected into the same tell-tale and buzzer circuit.

Refer to ENGINE COOLING SYSTEM (SEC. 6K) of this manual for information applicable to the sending unit located in the engine.

Refer to RADIATOR AND SURGE TANK (SEC. 13) of this manual for information applicable to the sending unit located in the radiator.

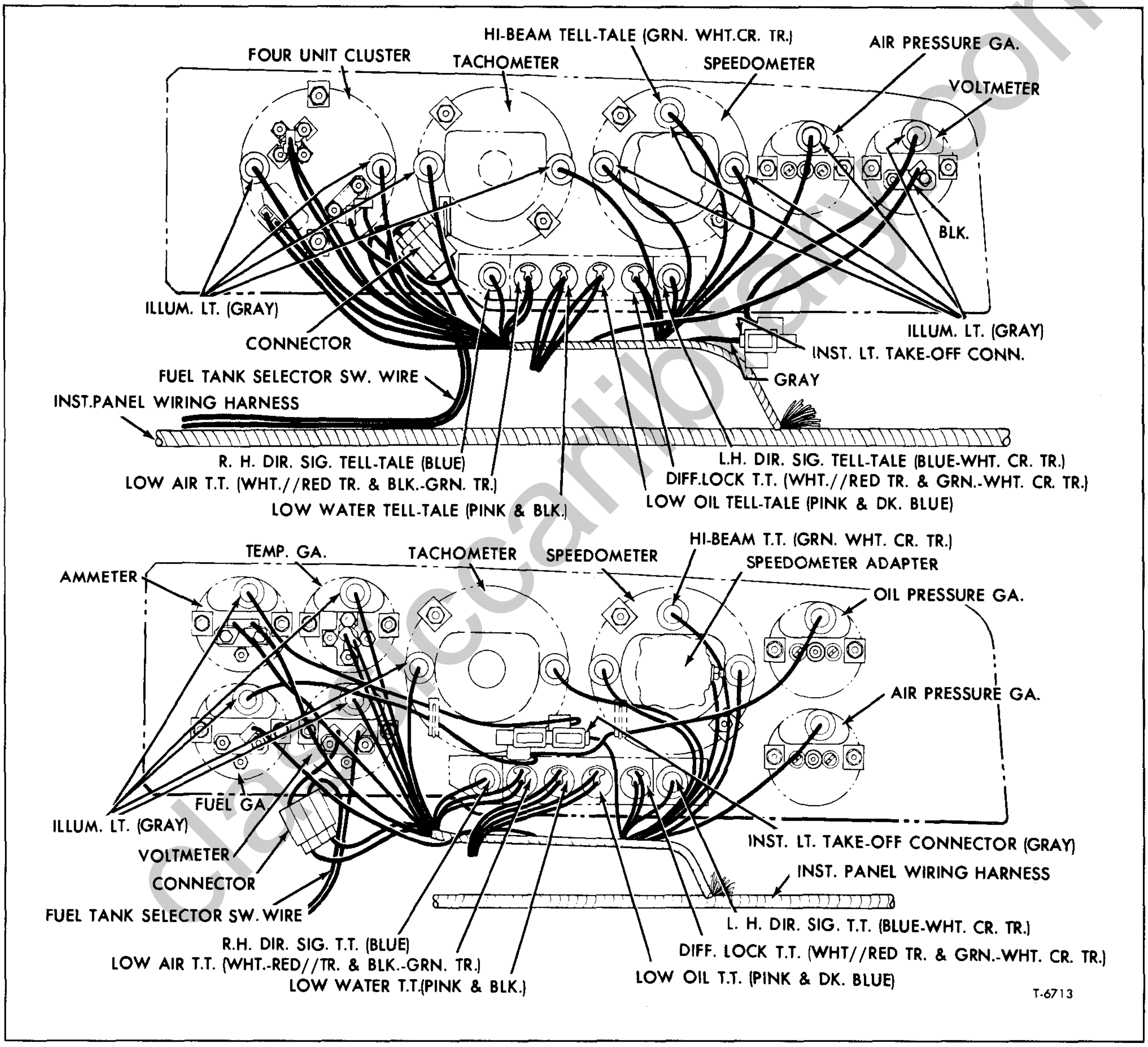


Figure 17—Connections at Rear of Instrument Cluster (Conv. Cab Models) (Typical)

OIL PRESSURE GAUGE

Oil pressure gauge on the instrument panel is marked oil pressure. Normal readings with engine hot are: Idling 9 to 18 pounds; Governed full-load speed 35 to 70 pounds. Engine must not be operated when oil pressure falls below 28 pounds at governed speed under full load.

If oil pressure falls below 4 pounds, the "LOW OIL" tell-tale will illuminate and alarm buzzer will sound. Stop vehicle immediately and correct cause of low oil pressure before proceeding.

To service sending units, refer to appropriate instructions in SERIES 53 AND 71 DIESEL ENGINE (SEC. 6C) of this manual.

VOLTMETER GAUGE

The voltmeter type charge indicator marked "VOLTS" located on instrument panel, is calibrated in volts and is divided into three segments. During operation the indicator hand should remain in the green segment to indicate normal battery condition. If indicator hand remains in left-hand red segment, an undercharge condition exists. If battery is low in specific gravity, voltmeter may remain at upper end of left-hand red segment until battery is recharged to a level that will allow system voltage to rise to normal level. If the hand goes over to the right-hand segment, an over-charge condition exists. If either a continuous undercharged or overcharged condition exists, check the charging system as described in "ALTERNATING CURRENT GENERATING SYSTEM" (SEC. 6Y) of this manual.

See Wiring Diagram for voltmeter connection at No. 3 circuit breaker.

AIR PRESSURE GAUGE

Air pressure gauge on the instrument panel is marked "AIR." The air pressure on these vehicles is very important as several systems of the vehicle depend upon air pressure for operation.

To service the air pressure switch refer to "AIR BRAKES" (SEC. 5B) of this manual.

FUEL GAUGE

Fuel gauge is marked "FUEL" on instrument panel cluster and indicates level of fuel in the tank.

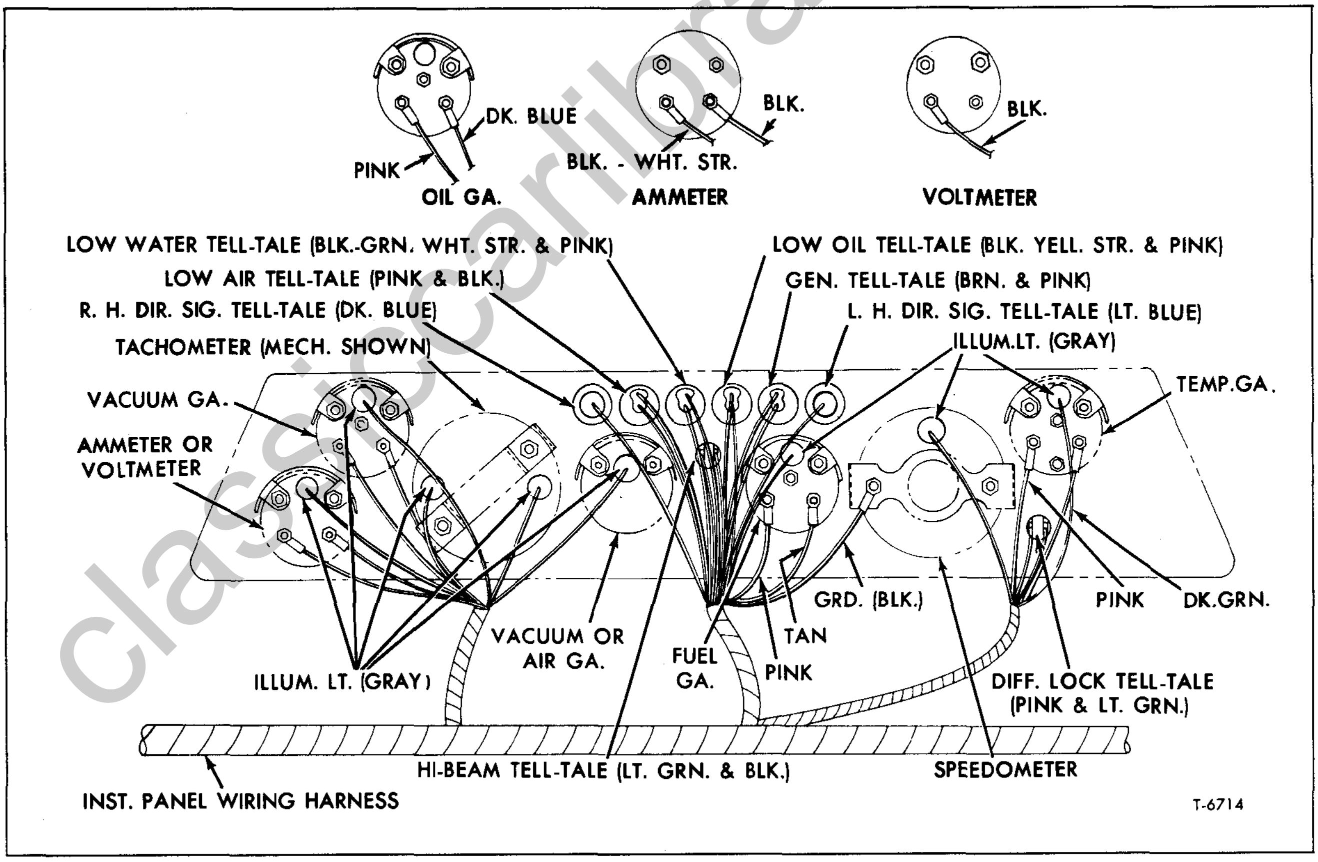
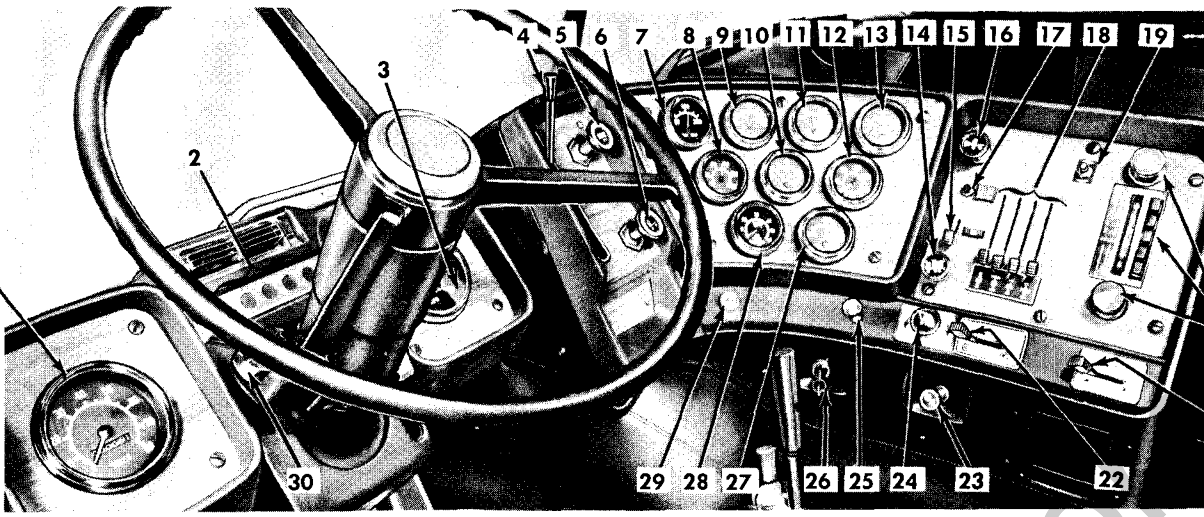


Figure 18—Connections at Rear of Instrument Cluster (Tilt Cab Models—70-80 Series) (Typical)



1 Speedometer
2 Tell-Tale Cluster
 a. L.H. Directional Tell-Tale
 b. Diff. Lock Tell-Tale
 c. Low Oil Tell-Tale
 d. Hot Engine Tell-Tale
 e. Low Air Tell-Tale
 f. R.H. Directional Tell-Tale
3 Tachometer
4 Trailer Brake Hand Control Valve
5 Trailer Emergency Brake Valve
6 Tractor Parking and Emergency Brake Valve
7 Engine Temperature Gauge
8 Air Gauge
9 Oil Pressure Gauge
10 Fuel Gauge
11 Voltmeter
12 Air Brake Gauge
13 Ammeter
14 Marker Blink Switch
15 Fan Switch
16 Light Switch
17 Master Circuit Breaker
18 Heater and Air Conditioning Controls
19 Window Lift Switch
20 Radio Controls
21 Differential Lock Switch
22 Front Brake Limiting Valve
23 Cigarette Lighter
24 Windshield Wiper Control
25 Engine Retarder Switch
26 Ignition Switch
27 Engine Temperature Gauge
28 Air Induction Restriction Gauge
29 Starter Switch
30 Directional and Hazard Warning Control Switch

T-6715

Figure 19—Instruments and Gauges on Console (Alum. Tilt Cab Models) (Typical)

For troubleshooting fuel tank gauge, refer to "FUEL TANK, LINES, AND GAUGE SYSTEM" (SEC. 8A) of this manual.

Fuel gauge is not repairable and must be replaced as a unit. NOTE: Sender unit in tank incorporates a 90-ohm resistor strip.

AMMETER GAUGE

The ammeter gauge is identified by "AMPERES" on the instrument panel and indicates rate of charge or discharge battery is receiving. The ammeter circuitry is specifically calibrated for either the 75 or 105 amp generator. The 75 amp generator uses a shunt which causes the meter to show a charge or a discharge rate of 60 amps full scale. The ammeter for 105-amp generator indicates a charge or discharge rate of 100 amps full scale.

Two fuses are used with the ammeter, one in each lead. Fuses protect wiring from short circuit damage. These fuses are located near the cranking motor and are mounted in water-proof connectors. The fuses should be checked if the ammeter becomes inoperative. If the fuses are found to be satisfactory a voltmeter should be connected from ground to each of the terminals on the backside of the ammeter. The voltmeter should read system voltage on both terminals. If it does, the fault lies with the ammeter, if not there is an opening in the wiring.

NOTE: The indicator pointer of the ammeter should remain at the center line when engine is not operating and all electrical equipment is turned off.

AIR RESTRICTION GAUGE

The air restriction gauge marked "AIR RESTRICTION FILTER" on the instrument panel in-

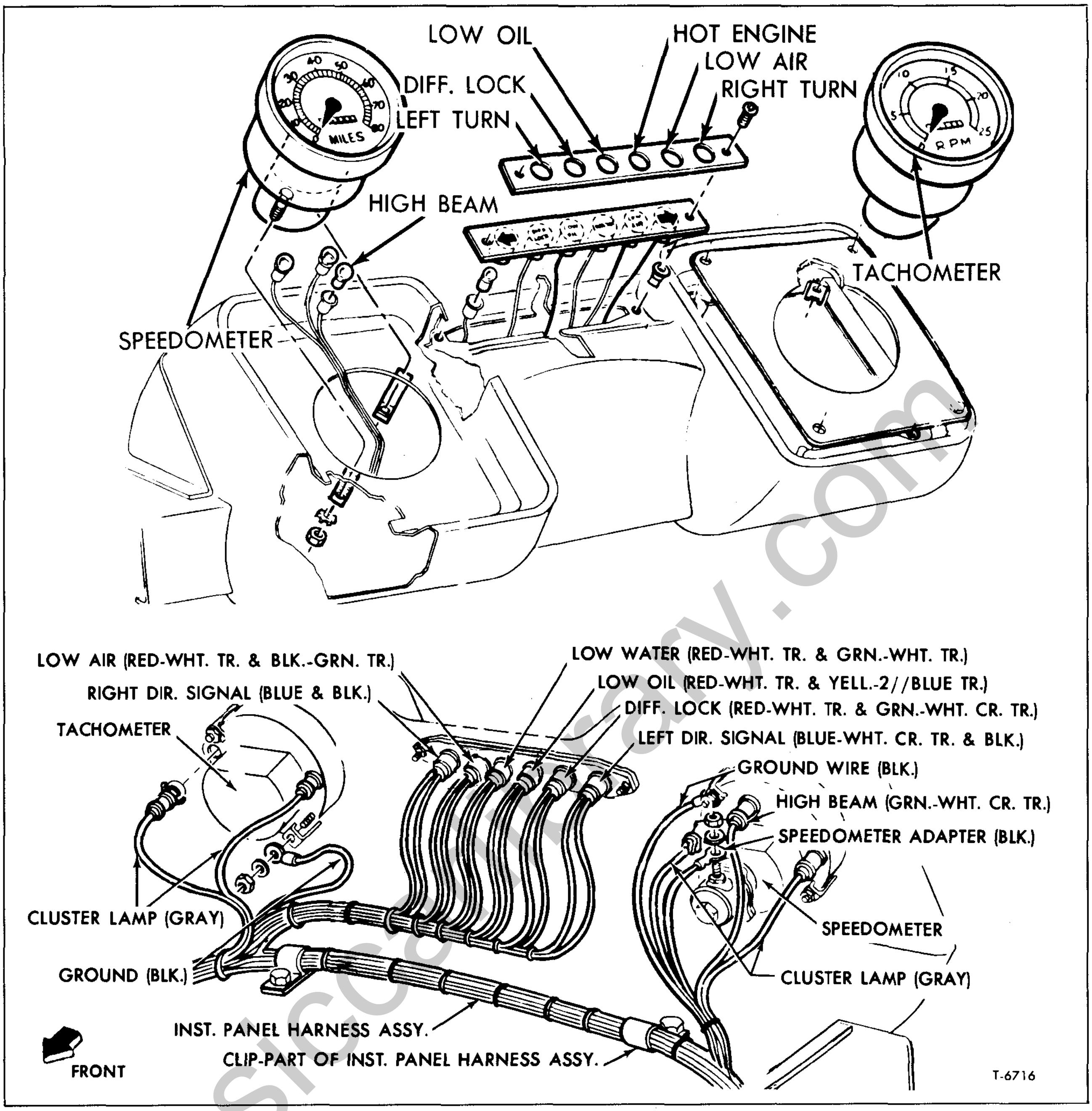


Figure 20—Rear View of Speedometer, Tachometer, and Tell-Tale Panel (Alum. Tilt Cab Models) (Typical)

dicates the condition of the paper air cleaner element. More than 25 inches of water indicates a clogged air cleaner element.

To service air cleaner element, refer to LUBRICATION (SEC. 0) of this manual. The air restriction gauge line is connected at the air horn between the air cleaner outlet and the inlet side of the blower.

AIR BRAKE GAUGE

The air brake gauge marked "BRAKE AIR" on the instrument panel shows applied air pressure to tractor brakes. When tractor brakes are released the gauge should fall to zero pressure. A heavy brake application would show more pressure than a light brake application.

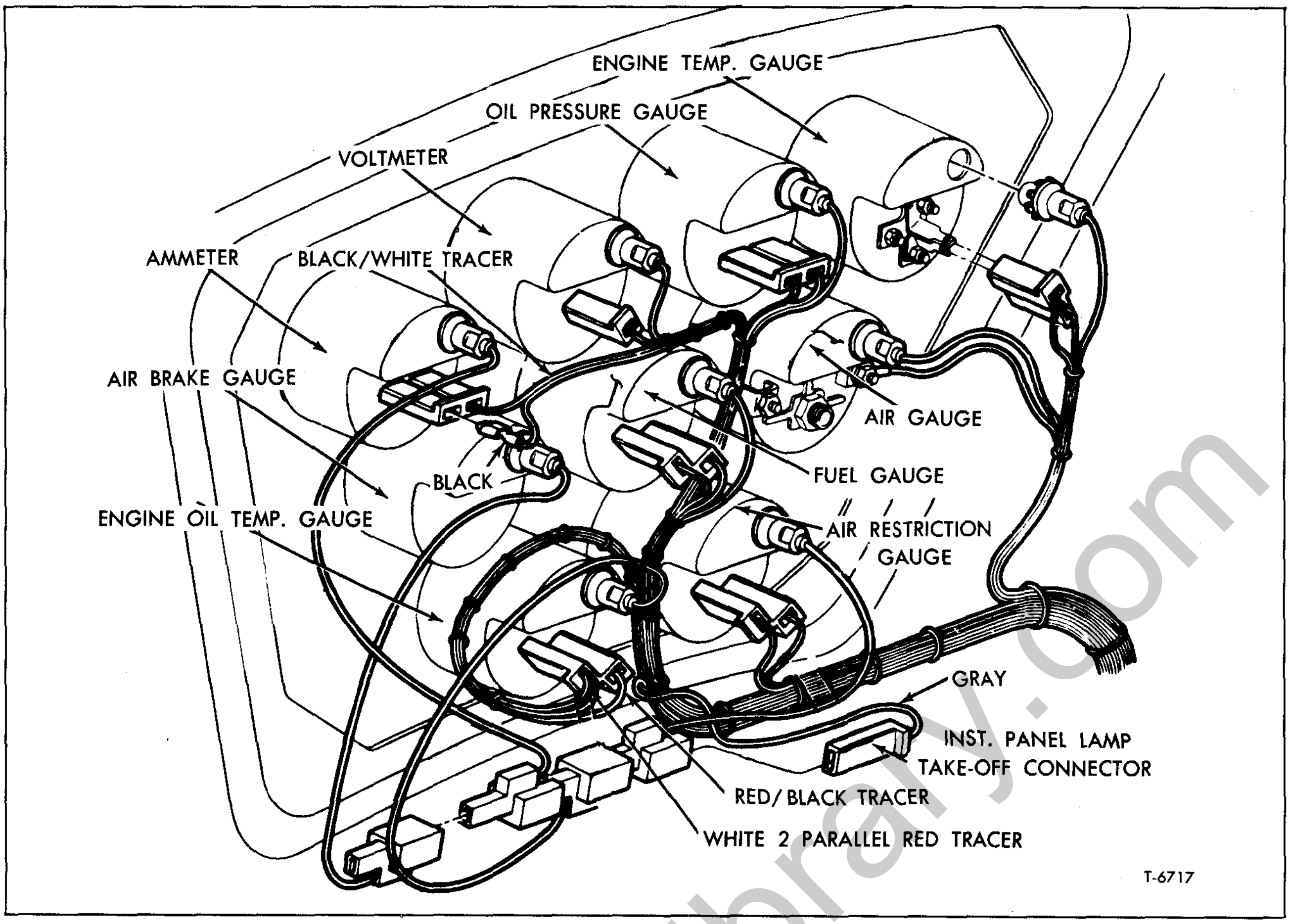


Figure 21—Rear View of Instrument Panel Gauges (Alum. Tilt Cab Models) (Typical)

LIGHTING SYSTEM

Headlights are equipped with "T-3" Sealed Beam units; all other lights are replaceable bulb type. Refer to "Light Bulb Data" at end of this section for bulb size and trade number. Refer to applicable wiring diagram for lighting system wiring circuits and wire identification.

MAINTENANCE

Periodically check to see that all wiring connections are clean and tight, that lighting units are tightly mounted to provide a good ground connection and that headlamps are correctly adjusted. Loose or corroded connections may cause a discharged battery, difficult starting, dim lights, and possible damage to generator and regulator.

By referring to applicable wiring diagrams, circuits may be tested for continuous circuit or shorts with a low reading voltmeter or a conventional test lamp.

HEADLIGHTS

All vehicles covered by this manual use the 7-inch single sealed-beam unit type headlights or dual headlights using four 5¾-inch units.

Both the 5¾-inch and 7-inch sealed-beam units are "T-3" type units incorporating three projecting guide points which are optically ground to provide flat surfaces at right angles to the light beam.

HEADLAMP BEAM ADJUSTMENT

The headlamps must be properly aimed to obtain maximum road illumination.

With the Guide "T-3" type sealed-beam units, proper aiming must be maintained since the increased range and power of this lamp make even slight variations from recommended aiming hazardous to approaching motorists.

IMPORTANT: Whenever a sealed-beam unit has been replaced or after repairs to front end

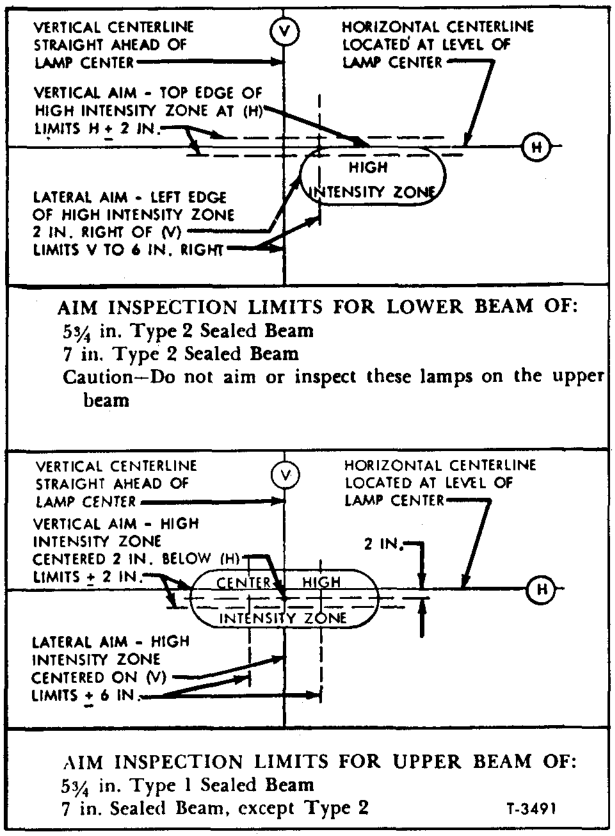


Figure 22—Visual Headlight Beam Adjustment (Typical)

sheet metal, the headlamps must be checked for proper aim.

In addition to providing superior lighting, the "T-3" type sealed-beam unit premits adjustment of the light without the use of an aiming screen and without requiring a large work area. Aiming is accomplished with the use of a safety aimer (J-6878-01). Instructions for using the Safety Aimer are supplied by the instrument manufacturer.

Horizontal and vertical aiming of each sealed-beam unit is provided by two adjusting screws, visible through the bezel, which move the mounting ring against tension of the coil spring.

Headlight beam adjustment requirements will vary on different vehicles due to size and distribution of load, type of standard or optional suspension, size of tires, tire pressures, and other factors. Average requirements are for the high intensity zone of the high beams of inner lights on dual units to be straight ahead and 2 inches below the headlight level at 25 feet. Low beam of outer lights of dual units and all 7-inch units should be adjusted so the high intensity zone of the light beam is just to the right of the headlight center and just below the headlight level at 25 feet (fig. 22).

To obtain correct adjustment, beam adjustment should be made with the vehicle loaded with the normal average load it will be carrying during the majority of its operation. Tires should be uniformly inflated to recommended pressure when adjusting headlight beams. Beam adjusting screws are identified in View A, figure 23, for dual units and in figure 24 for single units.

In all cases, it must be remembered that state or local legislation and specific vehicle conditions will govern the final aim for the best and safest lighting. Especially in the case of vehicles carrying widely varying loads during night-time operation, the final decision as to safe operation must still be made on the basis of "the most light on the road with the least annoyance to oncoming traffic."

DUAL SEALED-BEAM UNIT REPLACEMENT

Removal (Fig. 23)

1. Using a hooked tool, disengage spring from headlamp retaining ring as shown in View B.
2. Rotate the sealed beam unit slightly to disengage mounting ring from horizontal and vertical adjusting screws, then pull the assembly forward to remove (View B).
3. Pull headlamp wiring connector off back of sealed beam unit.
4. Remove screws which attach retaining ring to mounting ring. Separate retaining ring from mounting ring and remove sealed beam unit and discard (View D).

Installation (Fig. 23)

NOTE: Sealed-beam unit with number "1" molded on top of lens must be used at inside light position and unit with number "2" on lens must be used at outside position.

1. Position sealed-beam unit in mounting ring, then place retaining ring over sealed-beam unit and attach to mounting ring (View D).
2. Move sealed-beam unit assembly into position and press wiring connector plug onto terminals on sealed-beam unit.
3. Press in on the assembly and rotate slightly to engage horizontal and vertical adjusting screws in slot in headlamp mounting ring.
4. Using the hooked tool, pull outward on retaining ring spring and engage in slot in retaining ring as shown in "View B."
5. Check headlight adjustment as explained under "Headlight Beam Adjustment" previously.

SINGLE SEALED-BEAM UNIT REPLACEMENT

Removal (Fig. 24)

1. Remove screws which attach headlamp bezel to mounting ring, then remove the bezel.
2. Remove screws which attach headlamp retaining ring to mounting ring. Using a hooked tool,

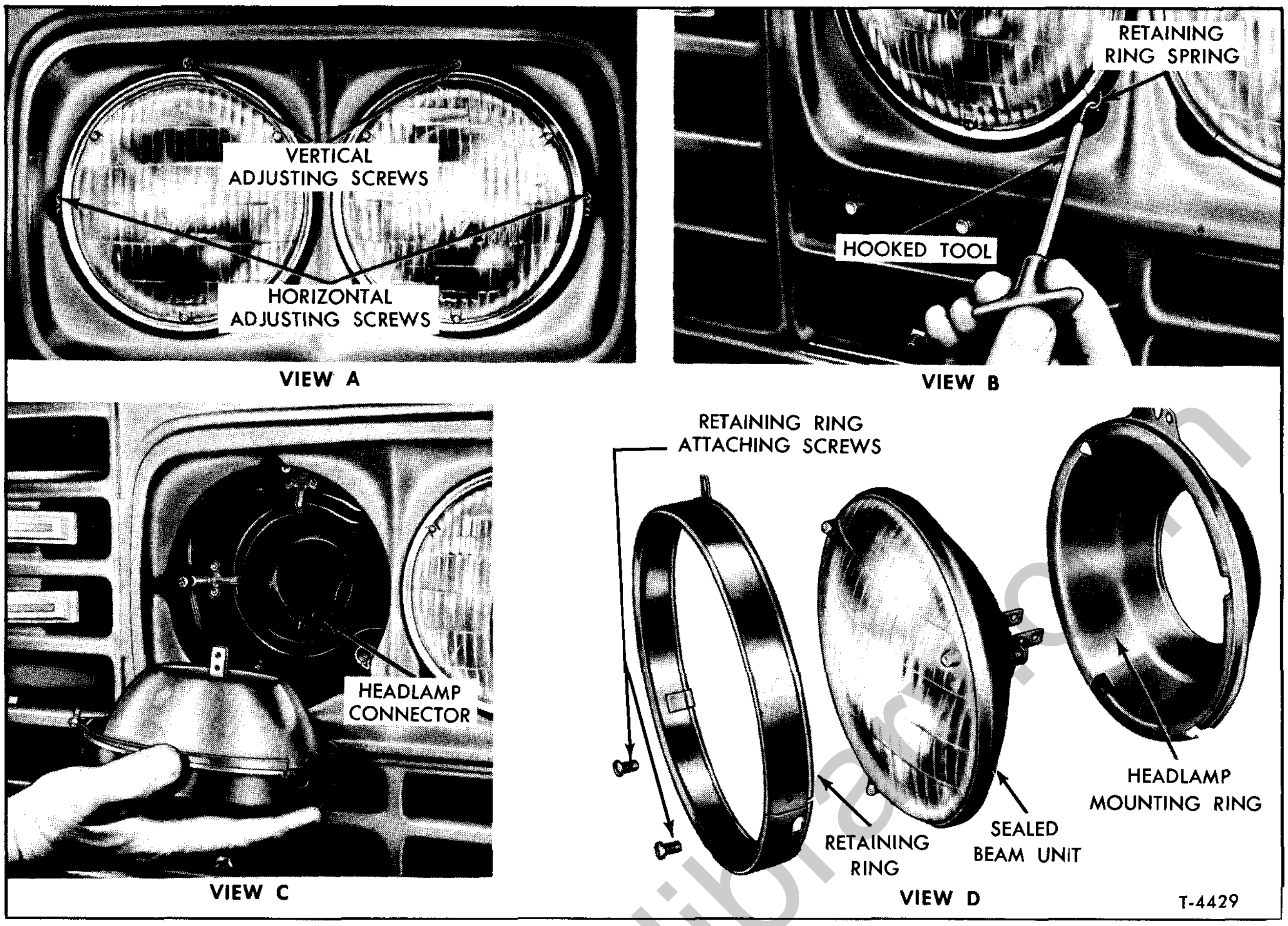


Figure 23—Dual Sealed-Beam Unit Replacement

release retaining spring from slot in retaining ring (inset, fig. 24).

3. Rotate headlamp unit to disengage assembly from headlamp adjusting screws.

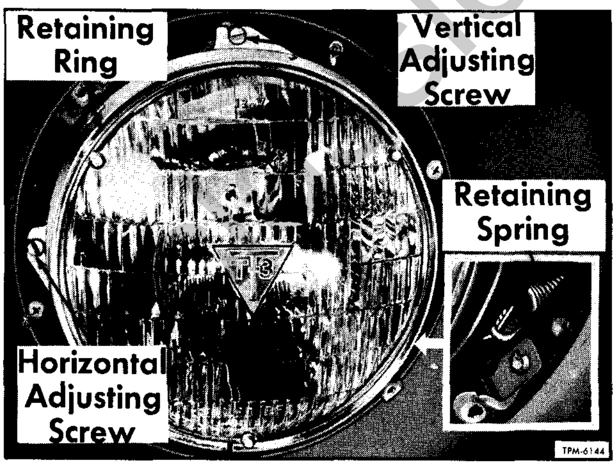


Figure 24—Single Sealed-Beam Unit Replacement

NOTE: Do not disturb adjusting screw.

4. Remove sealed-beam unit from mounting ring and pull wiring connector plug off back of unit.

Installation (Fig. 24)

1. Push wiring connector plug over blade-type terminals on back of sealed-beam unit.
2. Install headlamp assembly in panel opening and rotate to engage mounting ring tabs with adjusting screws.
3. Using a hooked tool, pull out on retaining spring and engage in slot near bottom of retaining ring (inset, fig. 24).
4. Check headlamp beam adjustment as described previously, then install bezel.

PARKING LIGHTS

Parking lights (when used) are illuminated with the main light switch pulled out to the first detent position. The parking light circuit is protected by an automatic reset type circuit breaker built into the main light switch.

BULB REPLACEMENT

Removal

On conventional cab models, bulb is accessible from rear of grille panel. Pull bulb and socket out of lamp housing, then press inward on bulb and turn counterclockwise to remove.

On steel tilt cab models, the parking lights are incorporated within the directional light assembly.

Installation

NOTE: Refer to "Light Bulb Data" at end of this section for bulb size and type.

On conventional cab models, install new bulb in socket and insert socket and bulb into lamp housing.

LAMP ASSEMBLY REPLACEMENT

On conventional cab models, remove bulb and socket assembly, then remove screws which attach grille to front end sheet metal and remove the grille. Remove two screws which attach the lamp assembly to the front grille panel. Remove the lamp assembly.

Remove three screws which attach directional lamp lens to housing, then remove the lens. Press inward on bulb and turn counterclockwise to release from socket. Press new bulb into socket and turn clockwise to secure. Replace gasket if damaged, then position lens on lamp housing and attach with three screws.

To install a new lamp assembly, position the assembly in opening and install two attaching nuts or screws. Insert bulb and socket assembly in lamp housing or connect harness at junction.

REAR LIGHTING

Due to numerous models, various rear lighting arrangements are used on vehicles covered by this manual. Rear lamp bulbs may be replaced by removing the lamp lens attaching screws and the lamp lens. The lamp housing may be replaced by removing the housing attaching nuts or screws, or by removing nuts and bolts from the mounting bracket.

NOTE: Refer to "Light Bulb Data" at end of this section for bulb size and type.

STOP AND TAILLIGHT

The stop and taillight is a combination-type lamp, having a double-filament bulb. The taillight filament is of 3 candlepower, and the stop light filament is of 32 candlepower.

BULB REPLACEMENT

Removal

Remove lens retaining screws, then remove lens and gasket from housing. Press bulb inward and turn counterclockwise to remove.

Installation

Refer to "Specifications" for bulb size and type. Note that J-slots in bulb sockets are of different depths and lugs on bulb base are located at different distances from end of base. Lugs and slots must be matched to permit installation of bulb. Insert bulb in socket, press inward and turn clockwise to lock in place. Position lens and gasket on body and attach with screws.

BACK-UP LIGHTS

The back-up light circuit is fed from the ignition switch control circuit. The back-up lamp switch, mounted on the transmission, is activated by the reverse shift rail (mechanical transmission) when the ignition or control switch is placed in the "ON" position and transmission shift lever is in reverse. Switch adjustment on vehicles equipped with the Allison Transmission is covered in "TRANSMISSION CONTROL LINKAGE" (SEC. 7A) of this manual.

If back-up lights become inoperative, disconnect the wiring harness connector plug from the switch. Connect both terminals in the connector with a jumper wire, then place the ignition or control switch in the "ON" position. If back-up lights operate, replace the switch.

BULB REPLACEMENT

NOTE: Refer to "Light Bulb Data" at end of this section for bulb size and type.

Remove screws which attach lens to lamp housing and remove the lens. Press bulb inward and turn counterclockwise to remove from socket.

Press new bulb into socket and turn clockwise to lock in place. Position lens and gasket on housing and attach with screws.

INSTRUMENT AND TELL-TALE LIGHTS

The instrument and tell-tale light bulbs are installed in pronged bulb sockets which snap into openings in instrument cluster, gauges, speedometer, and tachometer case.

Instrument panel lamp circuit on conventional cab and Series 70 through 80 tilt cab models is protected by a 3-amp fuse located on the fuse block. On alum tilt cab models, the lamp circuit is protected by a 5-amp circuit breaker on the

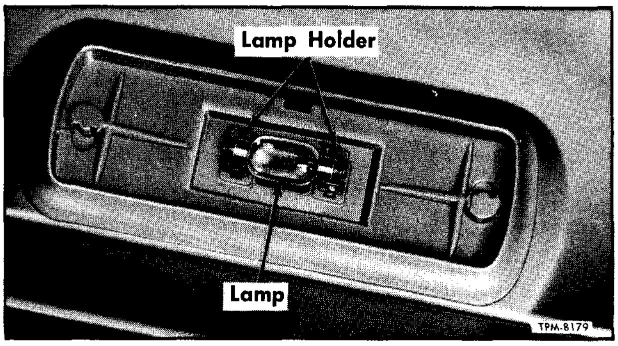


Figure 25—Dome Light (Tilt Cab Models—70-80 Series) (Typical)

circuit breaker and junction panel located inside the console behind the instrument panel.

CAB LIGHT

The cab light, used on conventional cab models, is mounted on the dash panel and provides lighting to cab interior, glove box, and across the fuse block. The light is operated by turning the main light switch knob to extreme counterclockwise position.

BULB REPLACEMENT

The tubular type bulb is mounted inside the glove box next to the fuse block and is retained by two spring-loaded clips. To remove the bulb, remove two screws which attach lens to dash compartment pillar, then remove the lens. Pull bulb forward until bulb releases from clips. Press new bulb in until secure in clips.

DOME LIGHT

On Series 70-80 tilt cab models, the dome lamp is mounted at rear of cab above rear window. The dome light is operated by rotating main light switch knob to extreme counterclockwise position.

NOTE: The dome light, used as optional equipment on conventional cab models, is mounted at rear of cab above rear window. The dome light is operated by rotating the main light switch knob to extreme counterclockwise position.

On Alum tilt cab models, the dome light mounted above the console and the sleeper compartment light are controlled by a separate "ON-OFF" type switch at the base of each light.

BULB REPLACEMENT

Series 70-80 Tilt Cab Models (Fig. 25)

Dome light lens is of molded plastic with a lug molded on edge of lens at center top and bottom. To remove lens, grasp between thumb and finger at center and squeeze sides together to disengage lugs from assembly. The tubular type bulb is held in position by two spring-loaded clips (fig. 28). To remove bulb, pull forward until bulb releases from clips. Press new bulb in until secure in clips, then position lens in assembly and press in until lugs snap into place.

Alum Tilt Cab Models (Fig. 26)

The dome light and sleeper compartment light lens are of molded plastic with two lugs molded on lens. To replace the bulb, twist lens counterclockwise until lugs on lens are aligned with slots on lamp base; then remove the lens. Press in on bulb and turn counterclockwise to remove from socket. Press new bulb into socket and turn clockwise to lock in place.

NOTE: The control switch can be readily replaced after removing the switch retaining nut and separating the wiring at spliced connector. Align lugs on lens with slots in base and turn clockwise to lock in place.

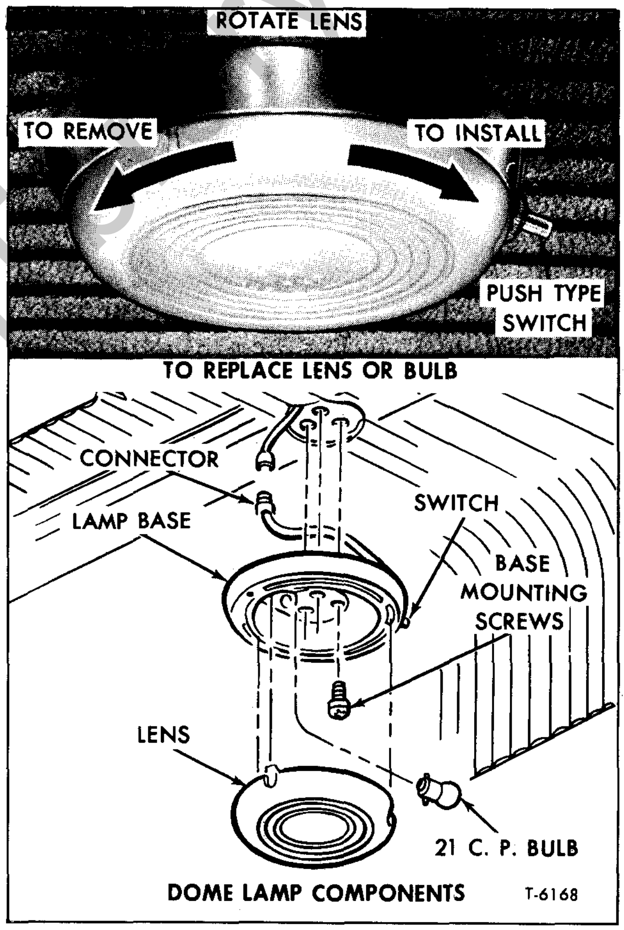


Figure 26—Dome or Sleeper Compartment Light (Alum. Tilt Cab Models)

CAB FRONT MARKER AND IDENTIFICATION LIGHTS

The front marker and identification lights are mounted across front top of cab. Marker light circuits on conventional cab and Series 70-80 tilt cab models are energized with main light switch in "ON" position. On alum tilt cab models, marker light circuit is energized with marker lamp switch in "ON" position.

To replace the bulb, remove screws which attach lens to lamp housing. Replace bulb and check operation of unit, then install lens and attach with screws.

DIRECTIONAL SIGNAL LIGHTS

Directional signal lights are either an integral part of the stop and taillight assemblies, or are mounted on each side of cab, or in combination.

NOTE: On some models, a combination directional and side marker lamp (fig. 27) is mounted on each side of cab.

The directional and/or hazard warning flasher is fed through a 20-amp fuse or circuit breaker from the battery bus bar. When the directional switch lever is placed in a right or left turn position or when hazard warning switch is energized, 12 volts is supplied from the flasher through the switch, then to front and rear directional lights.

An arrow at either side of the tell-tale cluster flashes when either the left or right signal light is illuminated. When turn is completed, switch lever is returned to "OFF" position by a cancelling cam, except alum tilt cab models which must be manually cancelled.

When hazard warning switch is energized, both directional signal and tell-tale lights will flash. To cancel or turn off the lights, pull the plunger out.

If directional tell-tale on instrument panel flashes in one position but not the other, check for the following:

1. Directional lamp bulb burned out.
2. Directional tell-tale lamp bulb on instrument panel burned out.
3. Incorrect directional lamp bulb installed.
4. Defective ground between bulb socket and mounting.
5. Defective directional control switch assembly.

If directional tell-tale lamps on instrument panel do not flash in either direction, check for the following:

1. Burned out fuse on fuse block or defective circuit breaker.

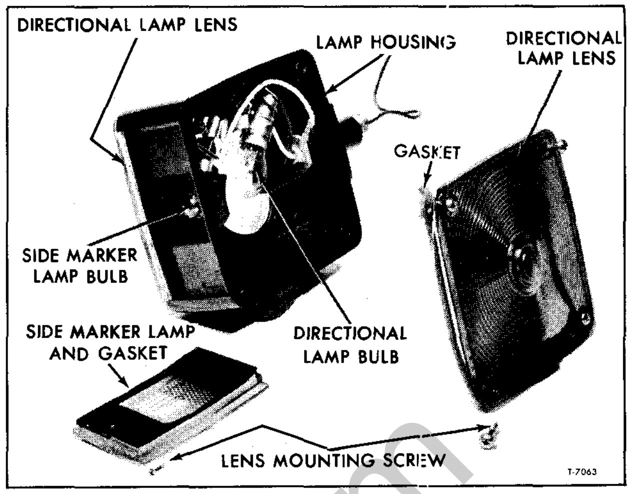


Figure 27—Directional and Side Marker Light (Typical)

2. Flasher terminals not properly engaged in junction block or defective flasher.
3. Short or open circuit. Check circuit referring to applicable wiring diagram.
4. Defective directional control switch assembly.

If directional tell-tale light does not cancel after completing a turn, remove the steering wheel as explained in "MECHANICAL STEERING" (SEC. 9A) of this manual and check for a worn or damaged cancelling cam.

MARKER BULB REPLACEMENT (Fig. 27)

Remove two screws which attach the amber marker lamp lens to light assembly, then detach lens. Press inward on bulb and turn counterclockwise to release from socket. Press new bulb into socket and clockwise to secure. Replace gasket, if damaged, then position lens on lamp housing and install attaching screws.

DIRECTIONAL SIGNAL BULB REPLACEMENT (Fig. 27 or 28)

Remove three screws which attach directional lamp lens to housing, then remove the lens. Press

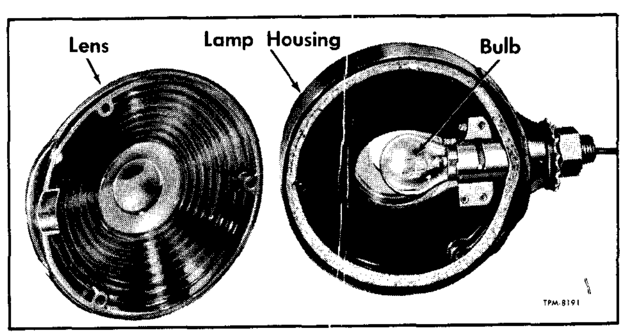


Figure 28—Directional and Parking Lights (Tilt Cab) (Typical)

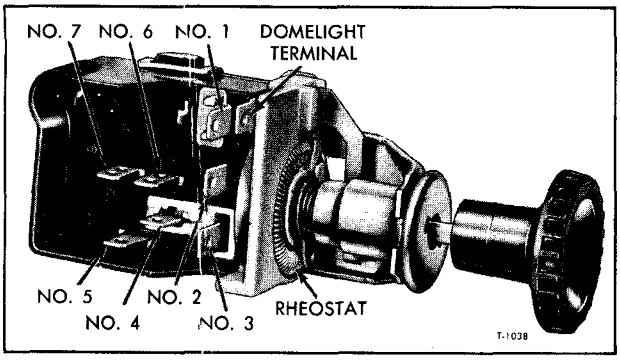


Figure 29—Main Light Switch (Typical)

inward on bulb and turn counterclockwise to release from socket. Press new bulb into socket and turn clockwise to secure. Replace gasket if damaged, then position lens on lamp housing and attach with three screws.

HAZARD WARNING SYSTEM

All vehicles are equipped with a hazard warning lighting system to be operated when on-the-road disability occurs. This system is fed from the battery and can be operated regardless of ignition or control switch position.

NOTE: Refer to applicable wiring diagram for wiring arrangement.

On conventional cab and Series 70-80 tilt cab models, a switch mounted on side of the directional signal control housing operates front and rear directional signal lights simultaneously. When hazard warning lights are operating, both directional tell-tale lights will flash. To cancel or "turn-off" the lights, pull hazard warning switch plunger out.

On alum tilt cab models, the switch lever is located on the directional signal switch housing below the turn signal lever. Pull hazard warning switch lever out to activate the system. To cancel or "turn-off" the lights, move turn signal lever up or down. The hazard warning signal lever is spring-loaded and will cancel the hazard warning lights when released by movement of the turn signal switch lever.

If switch becomes inoperative, check for a blown fuse, defective circuit breaker, or a weak flaher. If this fails to correct the condition, replace the hazard warning or directional signal switch.

NOTE: The hazard warning switch shown in figure 33 may be replaced as explained under "Directional Signal Control Assembly" later in this section.

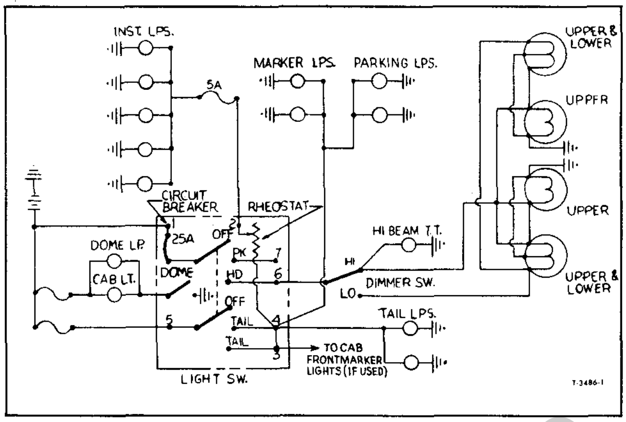


Figure 30—Main Light Switch Circuit Diagram (Conv. Cab Models) (Typical)

MAIN LIGHT SWITCH

The main light switch, mounted on the instrument panel, is shown in figure 29. A circuit diagram for conventional cab models is shown in figure 30, and a circuit diagram for series 70, 80 tilt cab models is shown in figure 31. A typical circuit diagram for alum tilt cab models is shown in figure 32.

A multiple connector, attached to the wiring harness, engages the blade-type terminals on the switch. The connector can be installed in only one position. A rheostat is incorporated in the instrument panel light circuit for purpose of dimming these lights if desired.

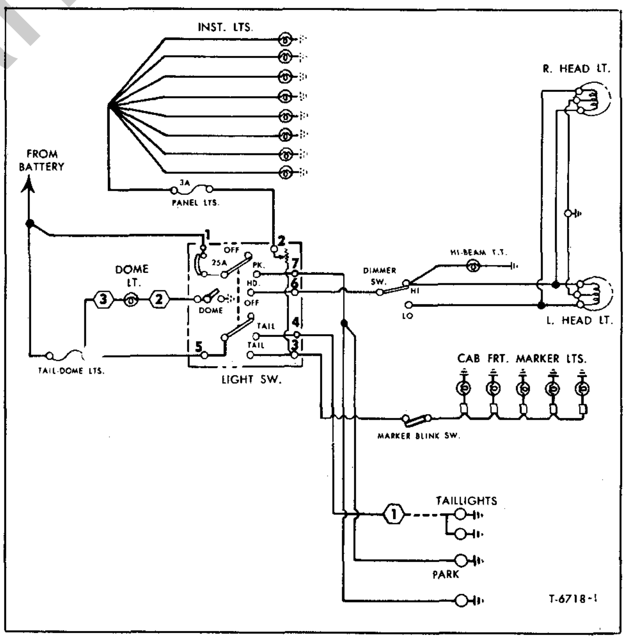


Figure 31—Main Light Switch Circuit Diagram (Tilt Cab Models)

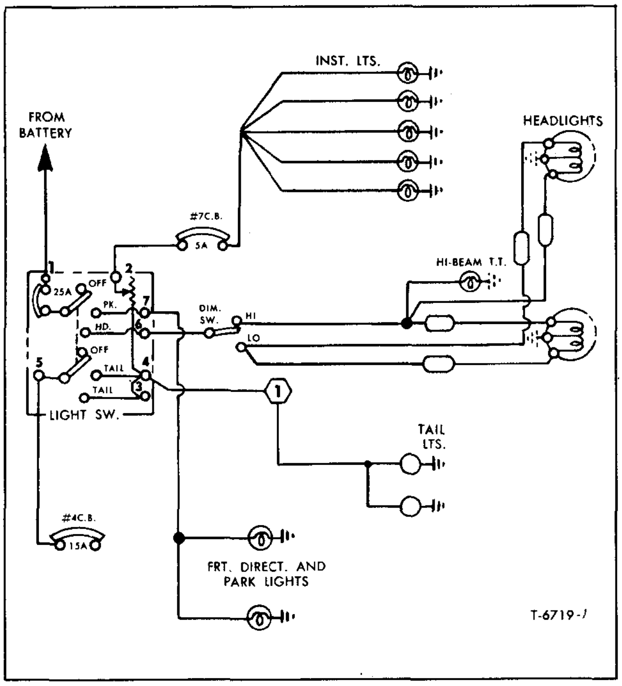


Figure 32—Main Light Switch Circuit Diagram (Alum. Tilt Cab Models)

The 25-amp automatic reset type circuit breaker built into the switch assembly protects the headlight and parking light circuits. Before replacing light switch, make sure trouble is in switch and not elsewhere in the lighting system by checking circuits with suitable equipment.

SWITCH REPLACEMENT

Removal

1. Pull wiring harness connector plug off switch terminals.
2. Pull switch knob out to extreme position, then press on spring-loaded release button on top of switch assembly and pull switch knob and rod all the way out.
3. Use a wide-blade screwdriver to remove ferrule securing switch to instrument panel, then remove switch assembly.

Installation

1. Position switch under instrument panel. with locating lug on switch frame engaging hole in instrument panel. Thread ferrule into switch frame and tighten firmly using a wide blade screwdriver.
2. Insert switch rod through ferrule and push in until spring-loaded latch engages groove near end of rod.
3. Install wiring harness connector plug on switch terminals pressing it firmly into place.
4. Check operation of all lights.

DIMMER SWITCH

Foot-operated dimmer switch is used to select headlight high or low beam. Switch is mounted on left side of cab floor panel and is operative when headlights are illuminated. Switch terminals are blade-type with connector plug attached to harness.

SWITCH REPLACEMENT

Conventional Cab and Alum Tilt Cab Models

Raise floor mat to gain access to switch.

Remove two screws which attach switch to floor panel and pull wiring connector plug off switch terminals.

Push wiring connector plug onto switch terminals. Position switch on cab floor panel and attach with two screws. Position floor mat over switch and wiring connector.

70-80, Tilt Cab Models

From inside cab, raise floor mat and remove two screws which attach switch to toeboard riser. Tilt cab and from underneath pull switch free from toeboard riser. Pull wiring connector plug from switch.

Push wiring connector plug onto switch terminals. Position switch under toeboard riser with button portion of switch extending through cab floor. From inside cab, install two screws to attach switch to toeboard riser.

STOP LIGHT SWITCH

Either a mechanically-operated or air-operated stop light switch is used on vehicles covered by this manual.

MECHANICALLY-OPERATED TYPE

The mechanically-operated type switch used on models equipped with vacuum-hydraulic brakes, is a plunger or lever type switch. With brake pedal released, edge of pedal lever holds switch plunger in, breaking circuit to the stop light. When brake is applied and pedal lever moves away from switch plunger, a spring within the switch moves the plunger out to complete the stop light circuit. Switch terminals are blade-type with wiring connections made through a connector plug on wiring harness. Switch cannot be disassembled; therefore, if switch becomes inoperative, it must be replaced.

When installing a lever-type switch, make sure lever on switch is located above pedal lug, otherwise switch will not be operative. Also, make sure wiring connections at switch are fully engaged.

After installing switch, it must be adjusted so that initial movement of brake pedal, measured at the pedal pad, will permit switch to close and complete stop light circuit. After adjusting and tightening switch mounting nuts or bolts, visually check operation of stop light to make sure stop light comes on when brakes are applied and goes out when brake pedal is released.

AIR OPERATED TYPE

The air operated type stop light switch is used on vehicles equipped with air brakes or I.C.C. trailer brake controls. Refer to "AIR BRAKES" (SEC. 5B) for information pertaining to this switch.

DIRECTIONAL SIGNAL CONTROL ASSEMBLY (ALUM. TILT CAB MODELS)

The control assembly consists of a switch, contact, wiring, and bearing assembly, and a cancelling cam (fig. 33). The control assembly is installed over the steering shaft inside the housing and the cancelling cam is attached to the steering wheel hub. The hazard warning switch mounted on side of the directional signal control housing is retained with two screws.

REMOVAL (Fig. 33)

1. Remove the steering wheel as directed in "Steering Wheel Replacement" in "MECHANICAL STEERING" (SEC. 9A) of this manual.
2. Remove steering shaft upper bearing sleeve.
3. Disconnect wiring harness at instrument panel harness connector.

NOTE: On some models it may be necessary to remove control assembly wiring from the wiring harness connector.

4. Remove screw attaching control lever to switch and remove lever.
5. Remove two screws which attach hazard warning switch to housing.
6. Remove three screws which attach control assembly to housing, then remove control assembly with wiring from housing.

INSPECTION

Inspect control switch, hazard warning switch, wiring and bearing (if used). Replace worn or damaged parts. Inspect cancelling cam on steering wheel hub and replace if worn or damaged.

INSTALLATION (Fig. 33)

1. Position control assembly in housing and attach to housing with three screws. Tighten screws firmly, however, do not exceed 30 in.-lbs. torque.
2. Position control lever on control assembly and attach with screw. Tighten screw firmly.

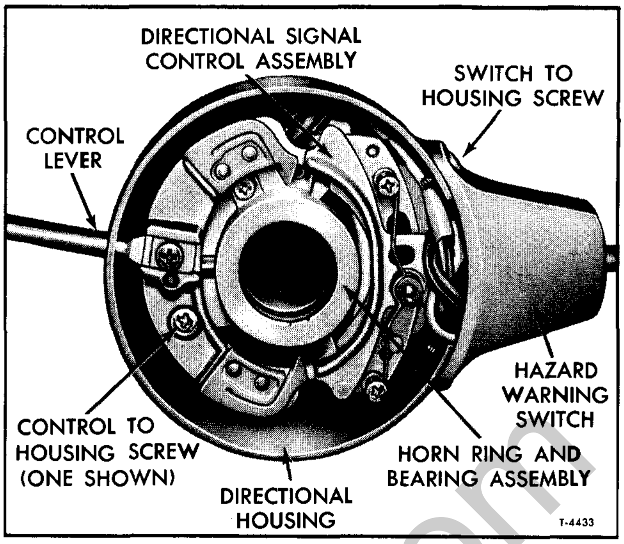


Figure 33—Directional Signal Control Assembly (Tilt Cab Models—Except Alum. Tilt) (Typical)

3. Install hazard warning switch on housing. Route switch wires down inside of control assembly on conventional cab models and outside of control assembly on tilt cab models.
4. Connect wires at dash connector.

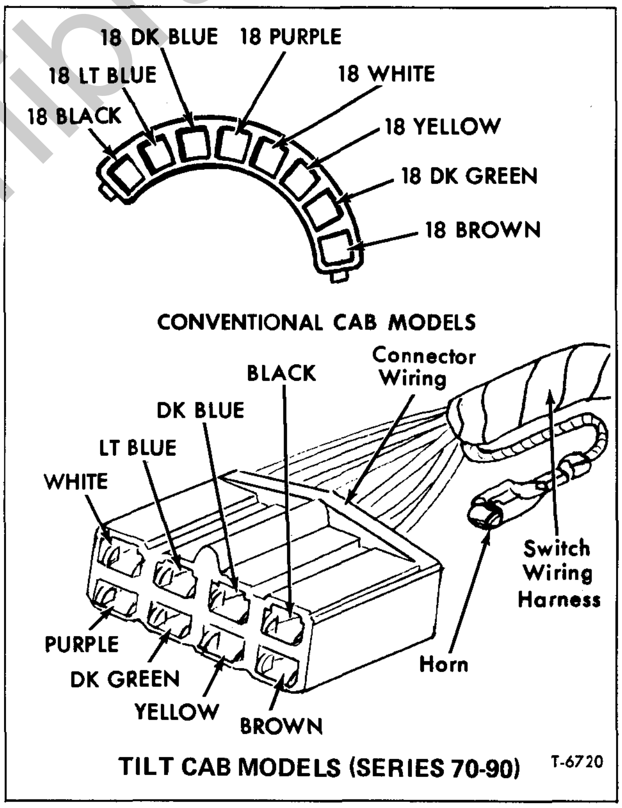


Figure 34—Directional Signal Wiring Harness Connector (Conv. Cab and 70-80 Tilt Cab)

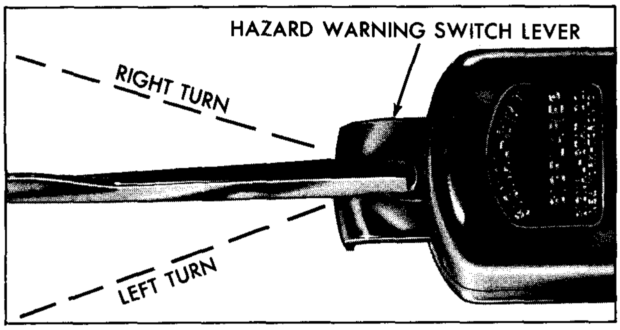


Figure 35—Directional and Hazard Warning Switch (Alum. Tilt Cab Models)

NOTE: On conventional and tilt cab models, insert terminals into connector cavities per designated wire colors as shown in figure 34.

5. Install steering shaft upper bearing sleeve, then install steering wheel as directed under "Steering Wheel Replacement" in "MECHANICAL STEERING" (SEC. 9A) of this manual.

DIRECTIONAL SIGNAL CONTROL ASSEMBLY (ALUM. TILT CAB MODELS)

The directional signal switch is mounted on the left side of steering column below the steering wheel (fig. 35). Green tell-tale arrows located in the tell-tale panel above the steering column, between the speedometer and tachometer, flash in conjunction with turn-signal lamps mounted at outside front corners of cab and at rear of vehicle.

To signal for a left turn, pull switch lever down. To signal for a right turn, push lever up.

NOTE: THIS SYSTEM IS NOT SELF-CANCELLING. AFTER TURN IS COMPLETED, DRIVER MUST MANUALLY SHUT THE SYSTEM OFF BY RETURNING SWITCH LEVER TO "OFF" POSITION.

The hazard warning switch lever is located on the turn signal switch housing below the turn signal lever. To activate the system, pull hazard warning switch lever out. When hazard warning system is energized, both tell-tale arrows flash simultaneously in conjunction with front and rear directional lights. To stop hazard warning signal, move the turn signal lever up or down. Hazard warning signal lever is spring-loaded and will shut system off when released by movement of the turn signal switch lever.

SWITCH REPLACEMENT

1. Disconnect wiring harness connector from chassis wiring harness connector located below steering column.
2. Remove control assembly wiring from the

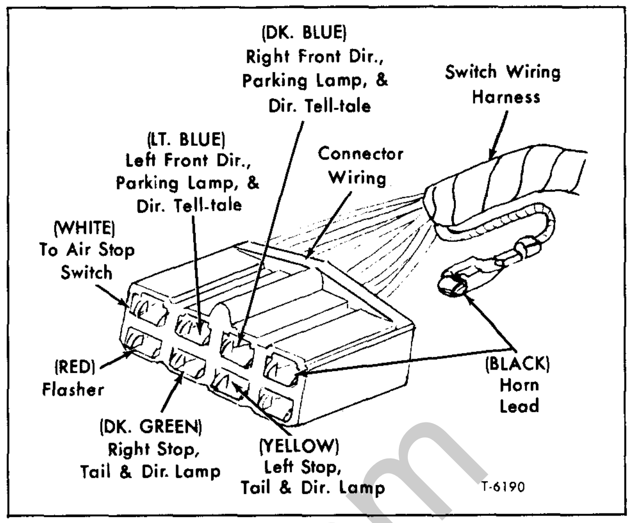


Figure 36—Directional Signal Wiring Harness Connector (Alum. Tilt Cab Models)

wiring harness connector noting the color of wires in the connector. See figure 36.

3. Tie a line to the wires removed from the connector to enable reassembly when wires and harness have been removed from steering column.
4. Remove screws which attach switch bracket to steering column, then pull switch with wiring harness from steering column. Remove line mentioned in Step 3 from wires.
5. The control switch can be separated by removing four attaching screws. However, if switch is damaged or broken, replace.
6. Installation procedure is the reverse of removal procedure, using the same line as described in Step 3 to pull wiring harness into position through steering column.

FLASHERS

Two prong specific load or variable load flashers are used in the directional and hazard warning system on vehicles covered by this manual. Refer to "Specifications" at end of this section for type of flasher and trade number.

On vehicles equipped with the specific load flasher, the tell-tale will not operate normally if one directional lamp bulb is taken out of the circuit.

On vehicles equipped with the variable load flasher, the directional tell-tale will operate even though one or more of the lamp bulbs are taken out of the circuit.

IMPORTANT: On vehicles equipped with the variable load flasher, each lamp bulb should be checked periodically for proper operation.

If directional tell-tale on instrument panel flashes in one position but not the other, check for the following:

1. Directional lamp bulb or indicator bulb burned out.
2. Incorrect directional lamp bulb installed.
3. Defective ground between bulb socket and mounting.
4. Defective directional control switch assembly.

If directional tell-tale on instrument panel does not flash in either direction, check for the following:

1. Burned out fuse on fuse block.
2. Defective flasher or flasher terminals not properly engaged in junction block.
3. Directional tell-tale bulb on instrument panel burned out.
4. Short or open circuit. Check indicator lamp circuit referring to applicable Wiring Diagram.
5. Defective directional control switch assembly.

If directional tell-tale light does not cancel after completing a turn (except Series 9502 tilt cab models), remove the steering wheel as explained in "MECHANICAL STEERING" (SEC. 9A) of this manual and check for a worn or damaged cancelling cam.

LIGHT BULB DATA

	BULB NO.	CANDLE-POWER
HEADLAMP		
Dual Sealed-Beam Units		
Inside Light (Type 1)	4001(L)*	37½ Watts
Outside Light (Type 2)	4002(L)*	37½-50 Watts
Single Sealed-Beam Unit	6013(L)*	45-50 Watts
PARKING LIGHTS (When Used)	67	4
DIRECTIONAL SIGNAL LIGHTS		
Combination Park and Direct. Sig	1157	32-3
Double Faced Directional and Side Marker	1156	32
Side Marker Light	57X	2
FRONT MARKER LIGHTS	67 or 1155	4
STOP, TAIL AND DIRECTIONAL LIGHT	1157	32-3
BACK-UP LIGHT	1156	32
LICENSE LIGHT	67	4
INSTRUMENT AND TELL-TALE LIGHTS	53 or 57	1 or 2
DOME LIGHT		
Except Alum. Tilt Cab Models	211	12
Alum. Tilt Cab Models	1411	21
HI-BEAM TELL-TALE LIGHT		
Except Steel Tilt Cab Models	57	1
Steel Tilt Cab Models	667582	1

SPECIFICATIONS

LOW AIR PRESSURE OR LOW VACUUM ALARM BUZZER

Make	Delco-Remy
Model	1116882
Point Opening (In.)	0.017
Closing Voltage	Adjust to Buzz at .25-.35 Amperes at 13.5-14.5 Volts

ENGINE ALARM BUZZER

Make	Delco-Remy
Model	1116914
Point Opening (In.)	0.015
Closing Voltage	Adjust to Buzz at .30-.35 Amperes at 13.5-14.5 Volts

ACCESSORY FEED RELAY (Alum. Tilt Cab)

Make	Delco-Remy
Model	1115841
Air Gap at Core Points Closed (In.)	0.012 (Min.)*
Point Opening (In.)	0.015-0.025
Closing Voltage (Range)	7-8
Sealing Voltage	10 Volts (Max.)

*Tolerance Plus or Minus 10%

FREQUENCY SENSING RELAY (Alum. Tilt Cab)

Make	Delco-Remy
Model	1115872
Voltage	12

COOLANT LOSS INDICATOR

Model	1596559

FLASHER ASSEMBLY

Specific Load—2-Prong	SIG STAT 144
Variable Load—2-Prong	SIG STAT 175

HORN RELAY

Model	2480982
Voltage	12

STARTER INTERLOCK RELAY

Make	Delco-Remy
Model	1115848
Point Opening (In.)	0.017-0.033
Opening Voltage (Range)	3.7-5.2

GENERATOR TELL-TALE RELAY

Make	Delco-Remy
Model	1115848
Point Opening (In.)	0.017-0.033
Opening Voltage (Range)	3.7-5.2

TRAILER I.C.C. MARKER LAMP RELAY

Make	Delco-Remy
Model	1115841
Air Gap at Core Points Closed (In.)	0.012 (Min.)
Point Opening (In.)	0.015-0.025
Closing Voltage (Range)	7-8
Sealing Voltage	10 (Max.)

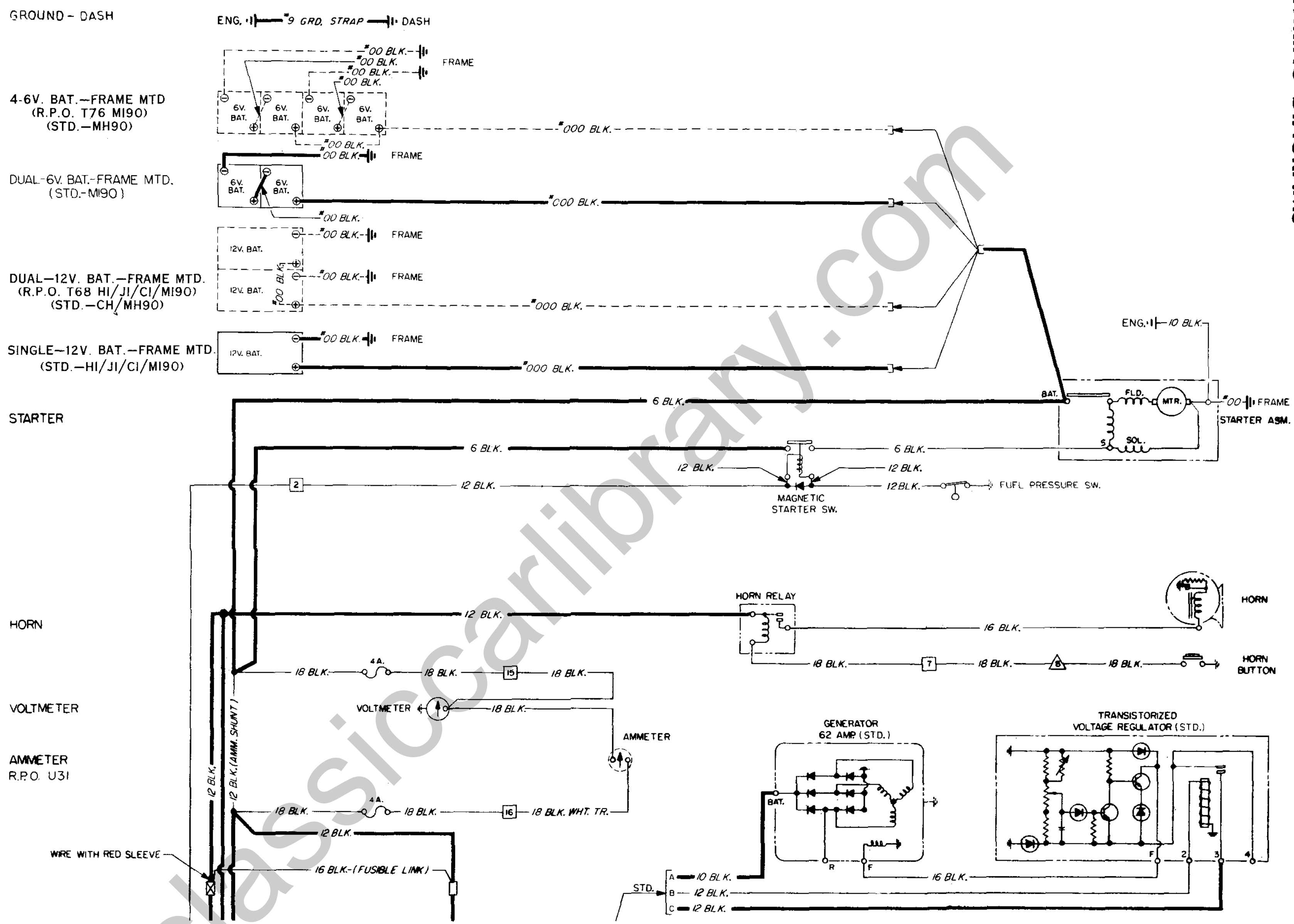


Figure 37—Cab, Engine, and Chassis Wiring—HI, JI, MH, MI-90
Sheet 1 of 7

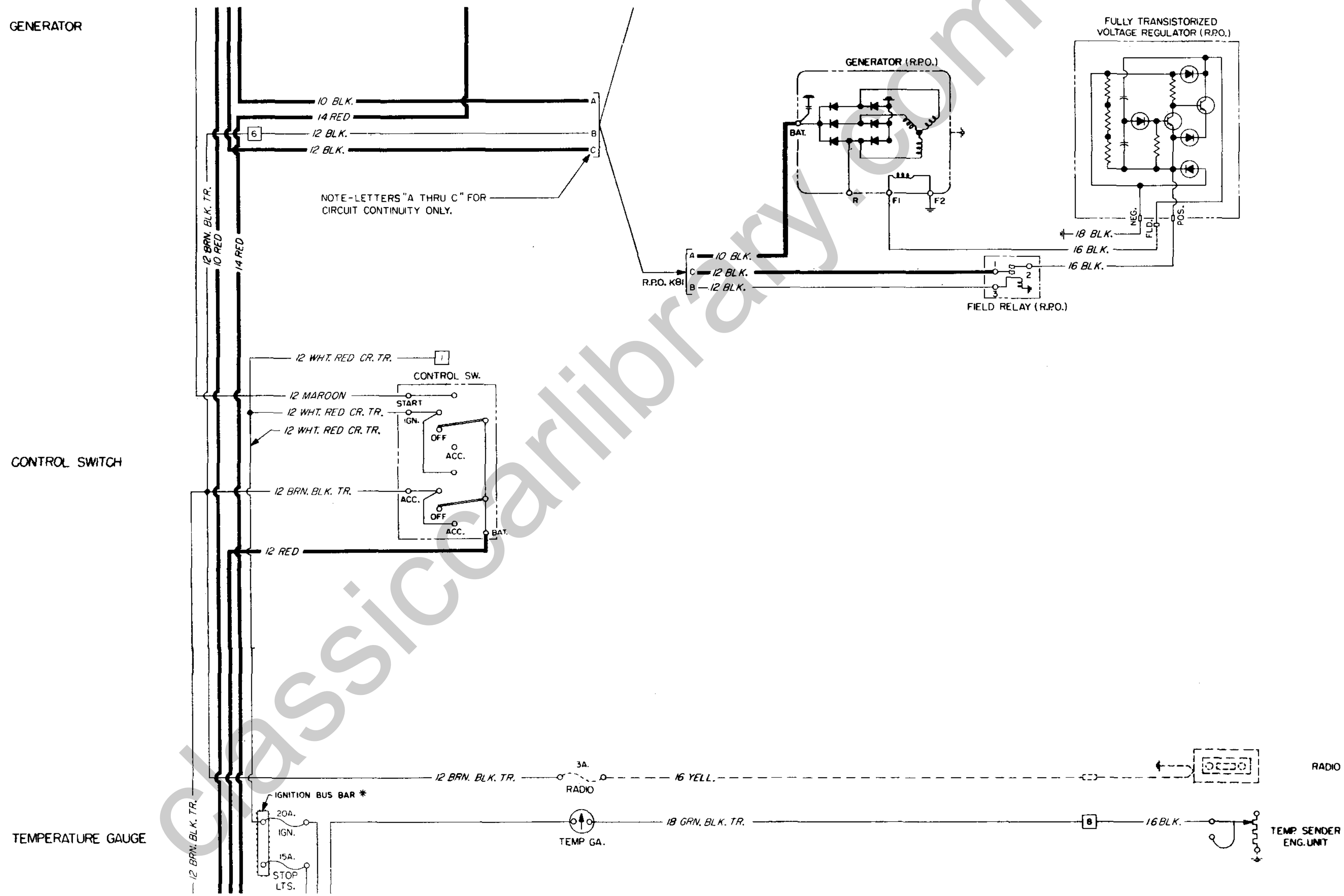


Figure 37—Cab, Engine, and Chassis Wiring—HI, JI, MH, MI-90

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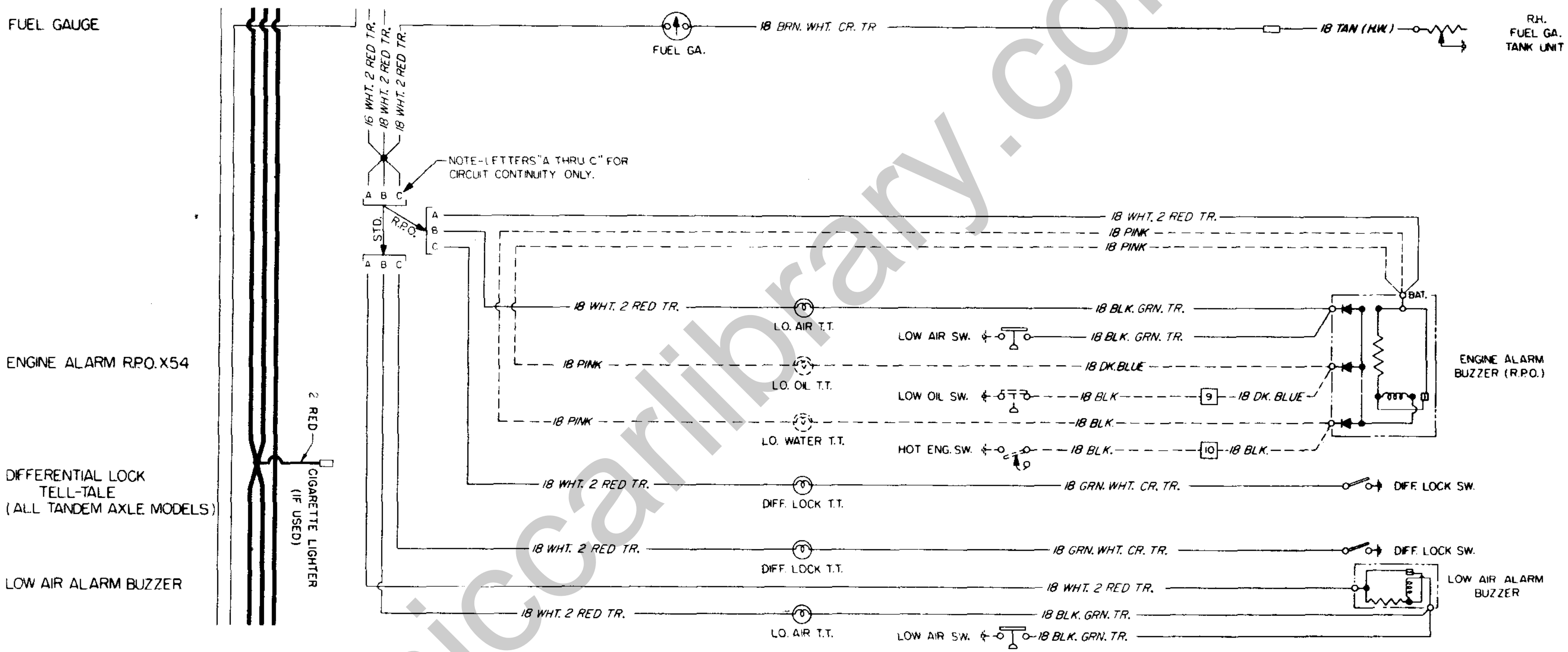

Figure 37—Cab, Engine, and Chassis Wiring—HI, JI, MH, MI-90
Sheet 3 of 7

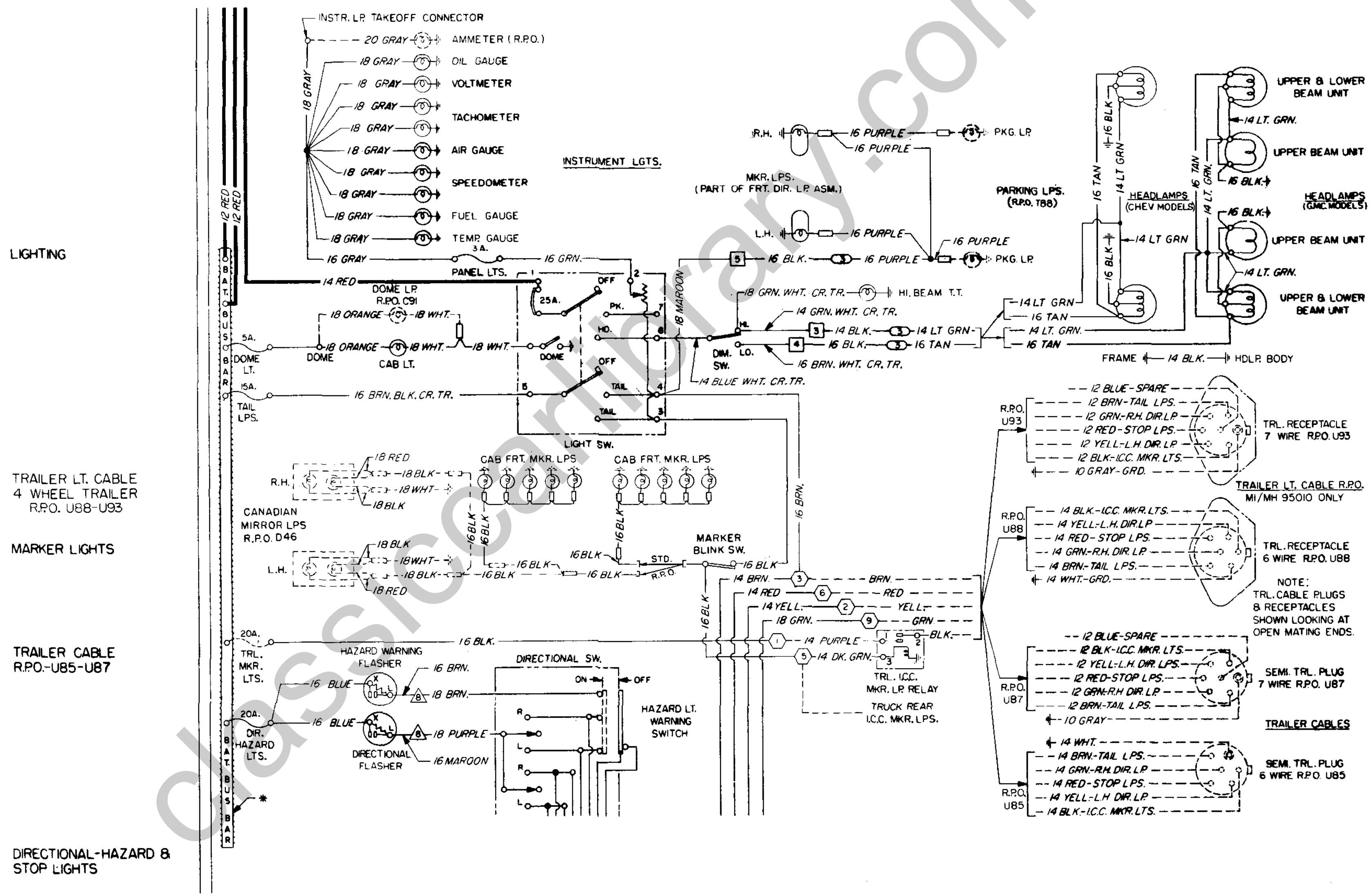

Figure 37—Cab, Engine, and Chassis Wiring—HI, JI, MH, MI-90

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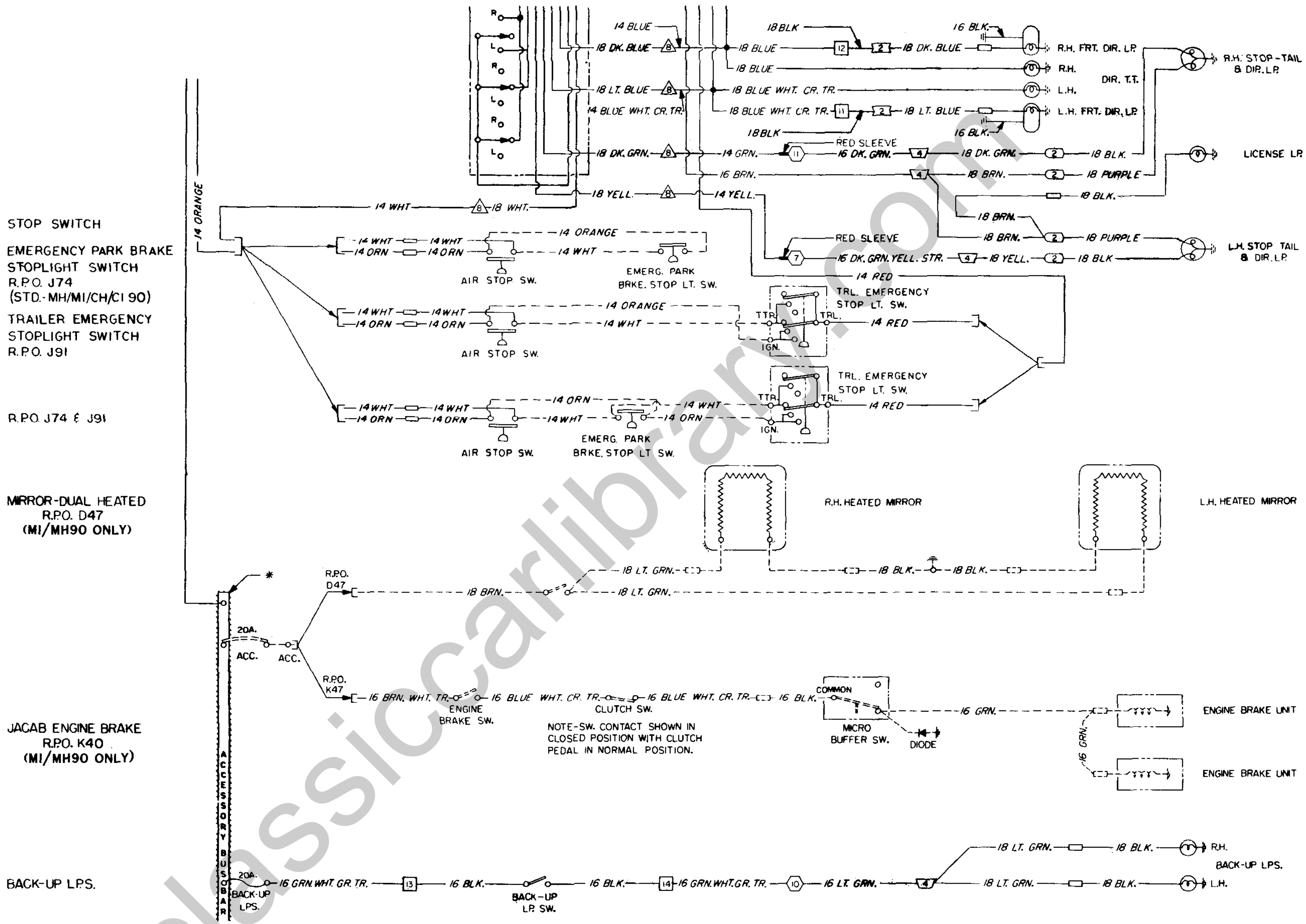

Figure 37—Cab, Engine, and Chassis Wiring—HI, JI, MH, MI-90
Sheet 5 of 7

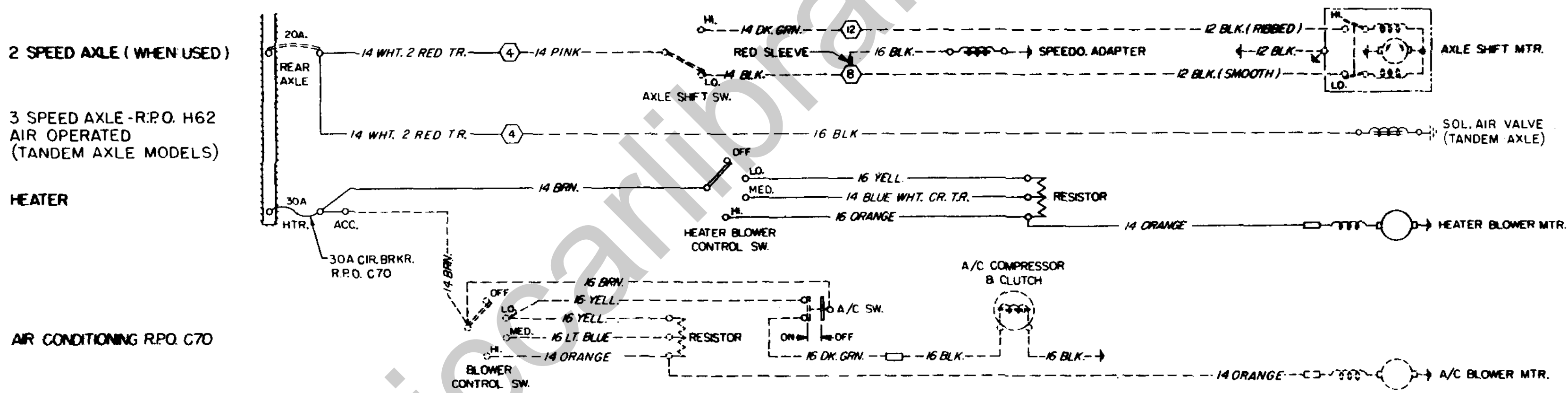

Figure 37—Cab, Engine, and Chassis Wiring—HI, JI, MH, MI-90
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CIRCUIT IDENTIFICATION

LEGEND

SYMBOL	JUNCTION		FUNCTION	LOCATION
	TERM. CAVITY (*1 THRU *16)	18 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO ENG. HARN.	ENG. COMPARTMENT-DASH PANEL-UPPER R.H. SIDE
	TERM. JCT. STUD-INNER (L.H.)			
	TERM. JCT. STUD-OUTER (R.H.)			
	8 WAY MULTIPLE CONNECTOR		INSTR. PANEL HARN. TO DIR. SW. HARN.	UNDER INSTR. PANEL AT STEERING COLUMN
	2 WAY MULTIPLE CONNECTOR		FUEL TANK SELECTOR SW. WIRE TO FUEL GAUGE TO INSTR. PANEL HARN.	UNDER INSTR. PANEL AT FUEL GA.
	3 WAY MULTIPLE CONNECTOR		ENG. HARN. TO HD. LP. & PARKING LP. HARN.	AT HEADLAMP ASM.
	2 WAY MULTIPLE CONNECTOR			
	4 WAY MULTIPLE CONNECTOR		STOP & TAIL LP. FRT. EXT. HARN. TO REAR STOP & TAIL LP. HARN.	L.H. FRAME RAIL (REAR)
	2 WAY MULTIPLE CONNECTOR		REAR STOP & TAIL LP. HARN. TO STOP & TAIL LP. ASM.	AT STOP & TAIL LP. ASM.
	SINGLE LINE CONNECTOR		RELATED CIRCUITS	
	12 POST JCT. BLOCK (*1 THRU *12)		INSTR. PANEL HARN. TO STOP & TAIL LP. FRT. EXT. HARN. & FUEL TANK WIRE; AXLE SHIFT MTR. SW. CABLE, AXLE SHIFT MTR. CABLE (WHEN USED); TRAILER CABLE	INSIDE CAB-R.H. REAR SIDE
	LINE FUSE		CIRCUIT PROTECTOR FOR AMMETER (WHEN USED) & VOLTMETER	AT 18 WAY MULTIPLE CONNECTOR
	TERM. OR CONNECTOR TERMINATION		RELATED CIRCUITS	
	SPLICE			
	FUSE		FUSE BLOCK	IN GLOVE BOX COMPARTMENT
	CIRCUIT BREAKER			

- - - - BROKEN LINES & SPECIFIED R.P.O. DENOTE WRG. & PARTS OTHER THAN STD. & NOT IN STD. WRG. HARN. ASM'S.

* BUS BAR PART OF FUSE BLOCK - FUSE BLOCK PART OF INSTR. PANEL HARN. ASM.

Figure 37—Cab, Engine, and Chassis Wiring—HI, JI, MH, MI-90
Sheet 7 of 7

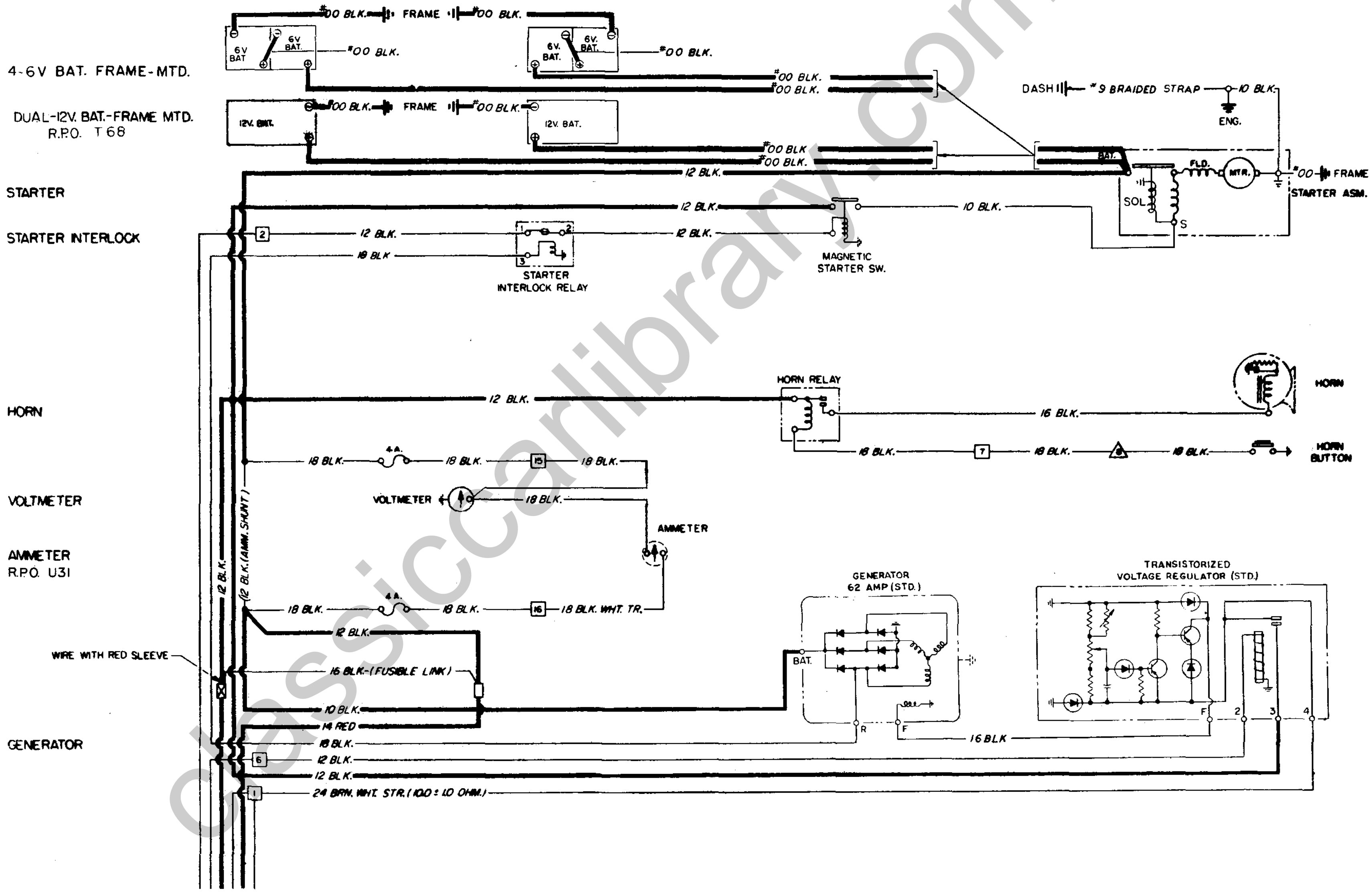


Figure 38—Cab, Engine and Chassis Wiring—HN, JN-90
Sheet 1 of 5

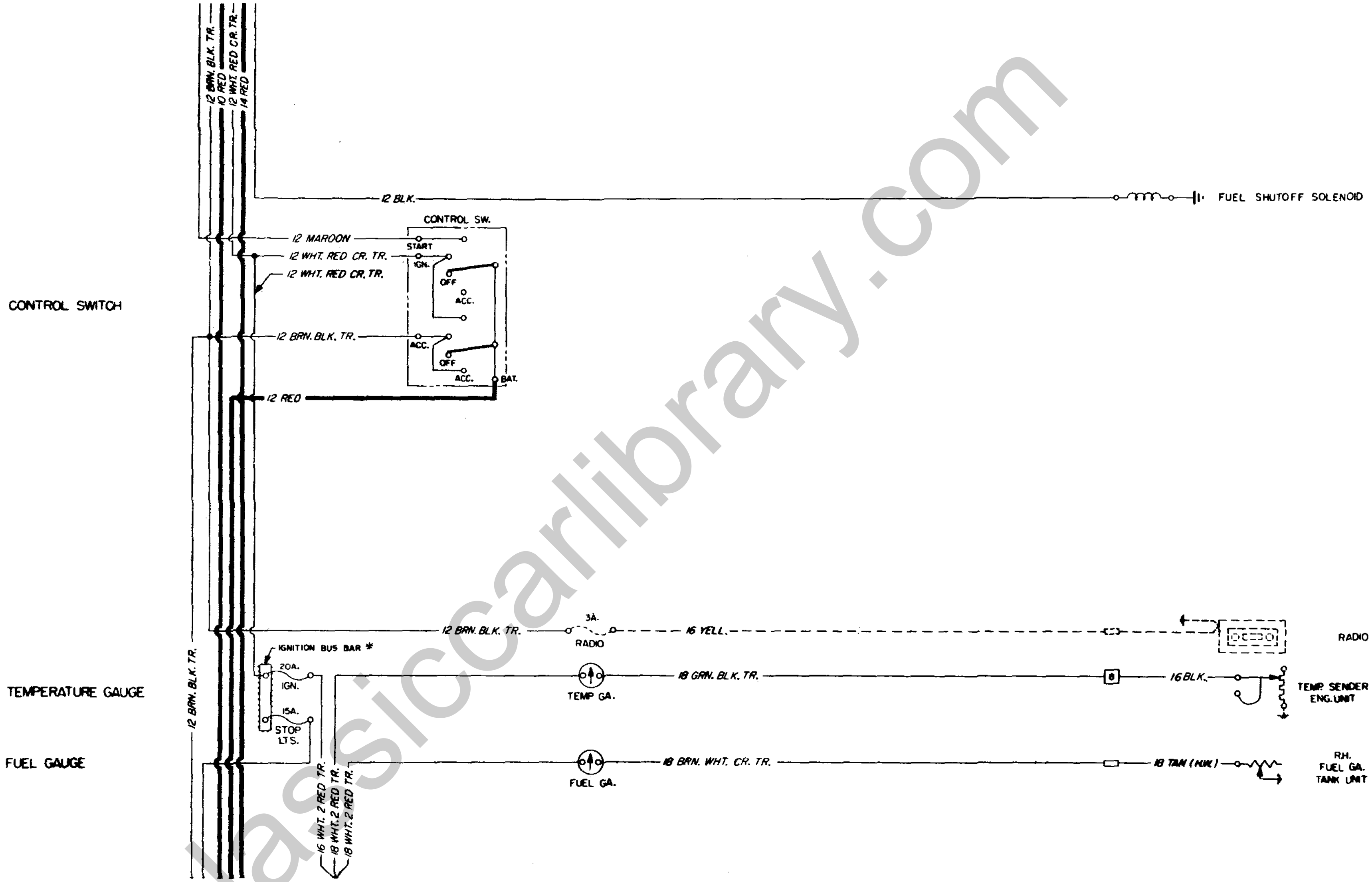


Figure 38—Cab, Engine and Chassis Wiring—HN, JN-90
Sheet 2 of 5

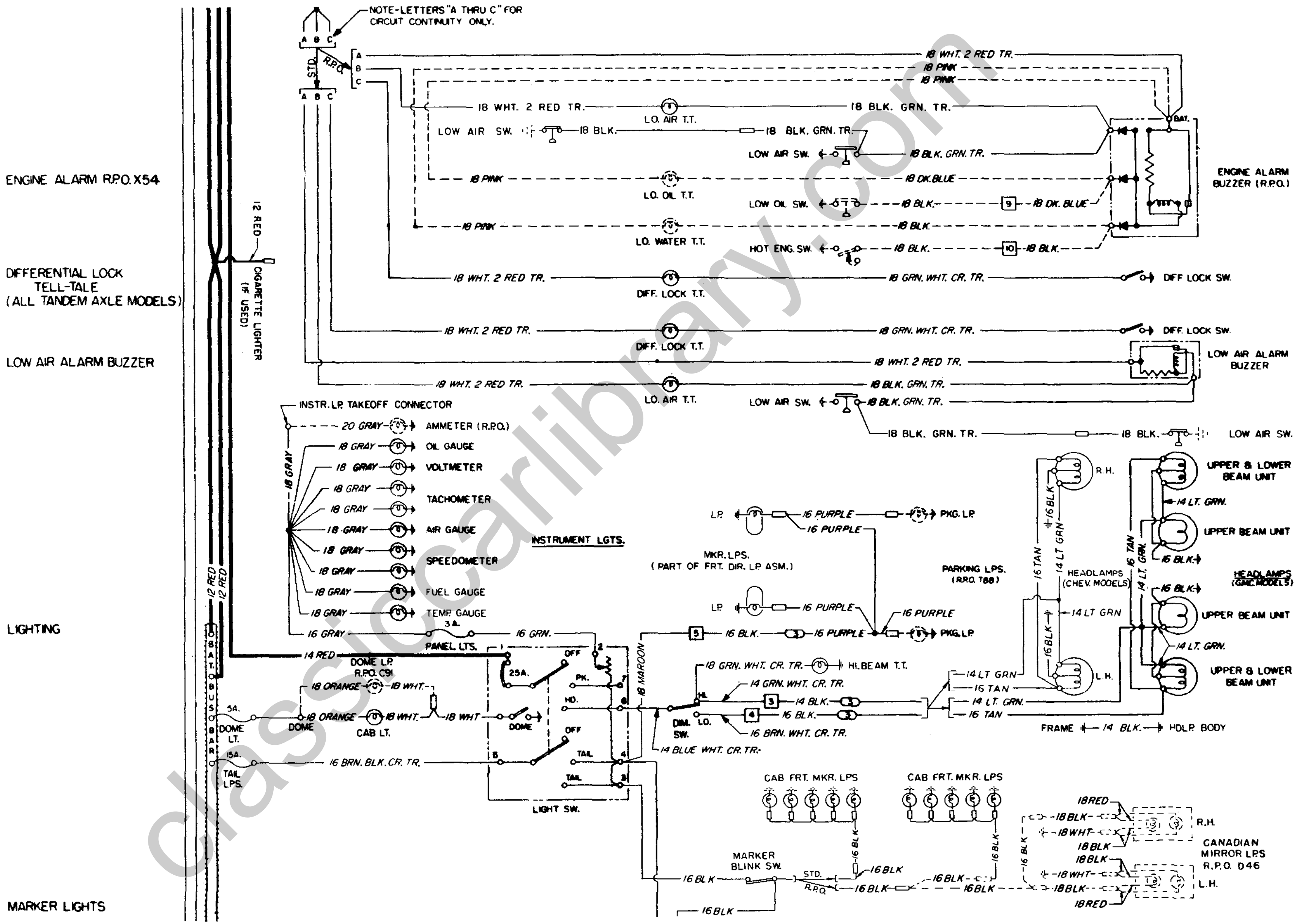


Figure 38—Cab, Engine and Chassis Wiring—HN, JN-90
Sheet 3 of 5

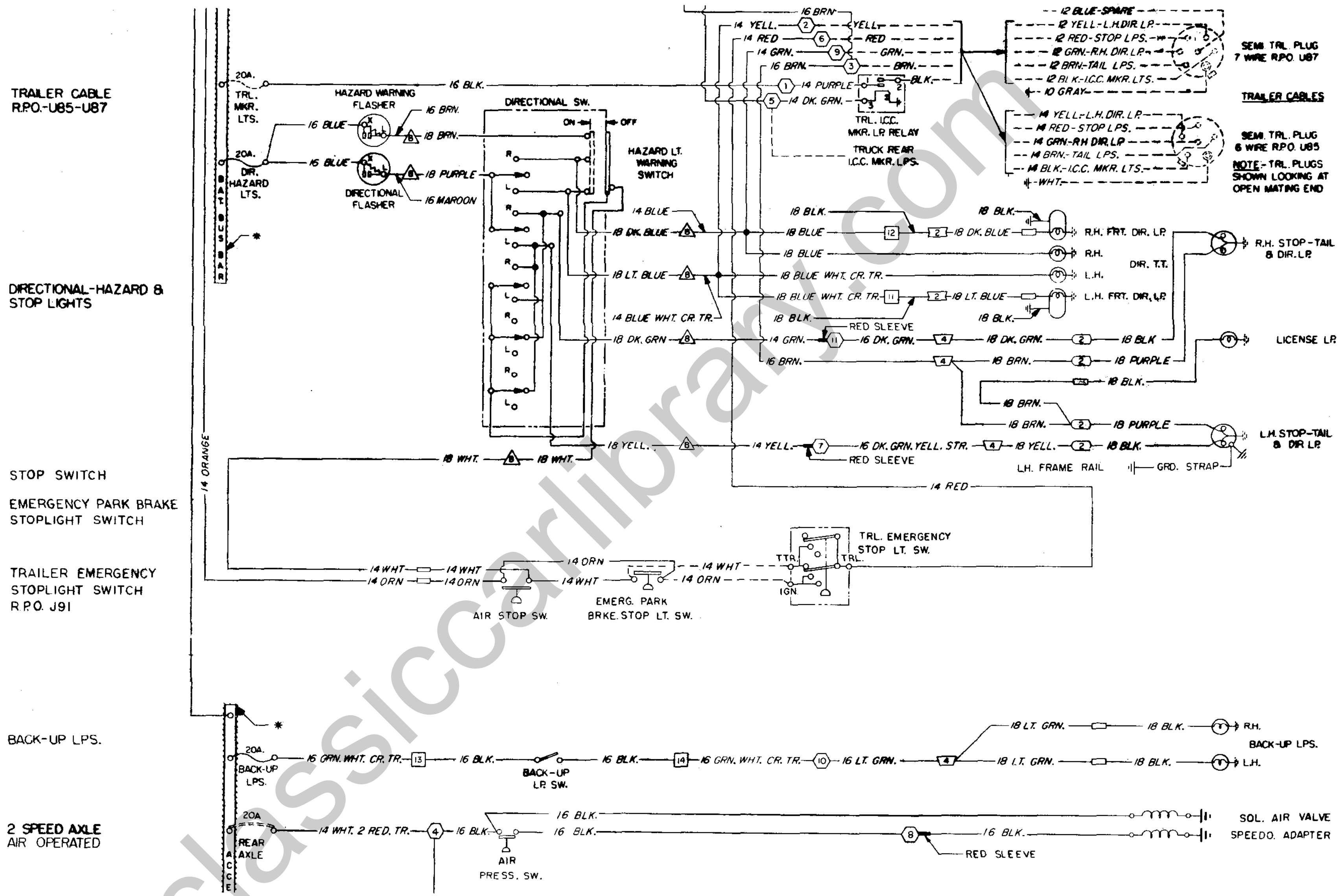
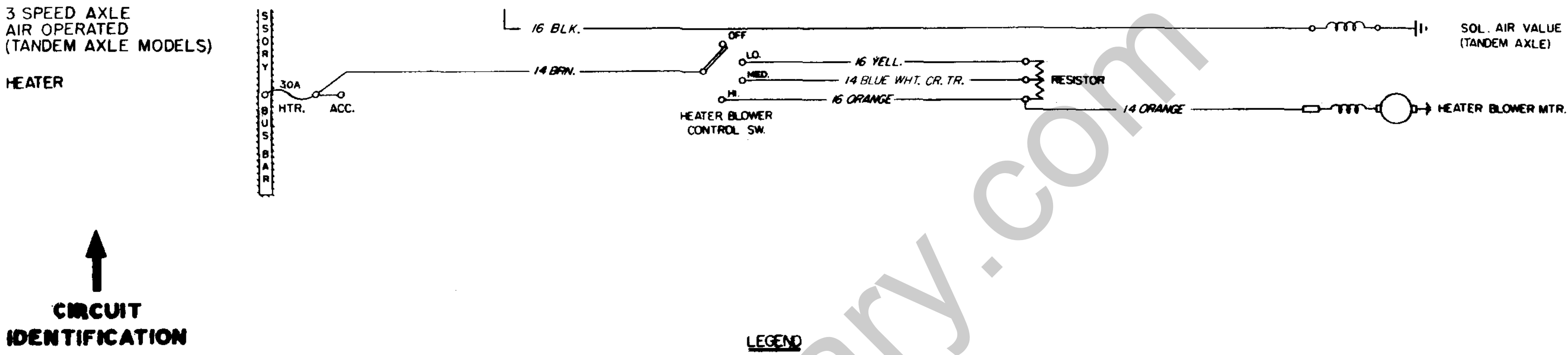


Figure 38—Cab, Engine and Chassis Wiring—HN, JN-90

Sheet 4 of 5



LEGEND

SYMBOL	JUNCTION	FUNCTION	LOCATION
	TERM. CAVITY (*1 THRU *16) / TERM. JCT. STUD-INNER (L.H.) / TERM. JCT. STUD-OUTER (R.H.) — 18 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO ENG. HARN.	ENG. COMPARTMENT-DASH PANEL-UPPER RH. SIDE
8	8 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO DIR. SW. HARN.	UNDER INSTR. PANEL AT STEERING COLUMN
2	2 WAY MULTIPLE CONNECTOR	FUEL TANK SELECTOR SW. WIRE TO FUEL GAUGE TO INSTR. PANEL HARN.	UNDER INSTR. PANEL AT FUEL GA.
3	3 WAY MULTIPLE CONNECTOR / 2 WAY MULTIPLE CONNECTOR	ENG. HARN. TO HD. LP. & PARKING LP. HARN.	AT HEADLAMP ASM.
4	4 WAY MULTIPLE CONNECTOR	STOP & TAIL LP. FRT. EXT. HARN. TO REAR STOP & TAIL LP. HARN.	L.H. FRAME RAIL (REAR)
2	2 WAY MULTIPLE CONNECTOR	REAR STOP & TAIL LP. HARN. TO STOP & TAIL LP. ASM.	AT STOP & TAIL LP. ASM.
	SINGLE LINE CONNECTOR	RELATED CIRCUITS	
	12 POST JCT. BLOCK (*1 THRU *12)	INSTR. PANEL HARN. TO STOP & TAIL LP. FRT. EXT. HARN. & FUEL TANK WIRE / AXLE SHIFT CABLE / TRAILER CABLE	INSIDE CAB-RH.REAR SIDE
	LINE FUSE	CIRCUIT PROTECTOR FOR AMMETER (WHEN USED) & VOLTMETER	AT 18 WAY MULTIPLE CONNECTOR
	TERM. OR CONNECTOR TERMINATION / SPLICE	RELATED CIRCUITS	
	FUSE / CIRCUIT BREAKER	FUSE BLOCK	IN GLOVE BOX COMPARTMENT

— — — BROKEN LINES & SPECIFIED R.P.O. DENOTE WRG. & PARTS OTHER THAN STD. & NOT IN STD. WRG. HARN. ASM'S.

* BUS BAR PART OF FUSE BLOCK - FUSE BLOCK PART OF INSTR. PANEL HARN. ASM.

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Figure 38—Cab, Engine and Chassis Wiring—HN, JN-90
Sheet 5 of 5

LEGEND

SYMBOL	JUNCTION	FUNCTION	LOCATION
8	8 WAY CONN.	INSTR. PNL. HARN. TO DIR.& HAZ. WARN. SW. HARN. ASM.	UNDER INSTR. PNL. AT STEERING COL.
2	2 WAY CONN.	ENG. HARN. TO R. H. HEADLAMP ASM. INSTR. PNL. HARN. TO L.H. HEADLAMP ASM.	AT HEADLAMP ASM.
2	2 WAY CONN.	STOP-TAIL & B/U LP. REAR WRG. HARN. ASM. TO STOP-TAIL LP. ASM.	AT STOP-TAIL LAMPS
3	3 WAY CONN.	RADIO CABLE ASM. TO INSTR. PNL. HARN.	AT RADIO IN CONSOLE COMPT.
3	3 WAY CONN.	INSTR. PNL. HARN. TO CAB MKR. & DOME LP. WRG. HARN. ASM.	UNDER INSTR. PNL. L.H. SIDE
4	4 WAY CONN.	ENG. HARN. TO STOP-TAIL & B/U LP. FRT. WRG. HARN. ASM. (DI/DH9502 ONLY) STOP-TAIL & B/U LP. REAR WRG. HARN. ASM. (FI/FH9502 ONLY)	L.H. FRAME RAIL
4	4 WAY CONN.	STOP-TAIL & B/U LP. FRT. WRG. HARN. ASM. TO STOP-TAIL & B/U LP. REAR WRG. HARN. ASM. (DI/DH9502 ONLY)	L.H. FRAME RAIL
	SINGLE LINE CONN.		RELATED CIRCUITS
	SINGLE LINE CONN. (DH/FH9502 ONLY)		RELATED CIRCUITS
o	TERMINAL OR CONN. TERMINATION		RELATED CIRCUITS
•	SPLICE		RELATED CIRCUITS
	LINE FUSE		RELATED CIRCUITS
*	BUS BAR	FEED FOR MULTIPLE CIRCUIT BREAKERS	ELECT. EQUIP. PNL.-CONSOLE COMPT.
BAT. AUX.	CIRCUIT BREAKER		ELECT. EQUIP. PNL.-CONSOLE COMPT.
	32 WAY CONN. (AS THRU JX)	INSTR. PNL. HARN. TO ENG. HARN.	R.H. SIDE-UNDER DASH
	6 POST JCT. (#1 THRU #6)	INSTR. PNL. HARN. TO TRAILER CABLE ASM.	ELECT. EQUIP. PNL.- CONSOLE COMPT.
2	2 WAY CONN.	INSTR. PNL. HARN. TO CAB WINDOW LIFT WIRE ASM.	R.H. SIDE-UNDER DASH
	5 POST JCT	PLUG TO BATTERY BOX HEATER	RADIATOR SHROUD-L.H. SIDE
2	2 WAY CONN.	INSTR. PNL. HARN. TO CLUTCH SW. WIRE ASM.	L.H. SIDE-UNDER DASH
4	4 WAY CONN	ENG HARN TO GEN HARN ASM	AT STARTER ASM
3	3 WAY CONN	INST PNL HARN TO COOLANT LOSS INDIC HARN ASM	ELEC EQUIP'T PNL- CONSOLE COMP'T

SPARES-ENG. HARN. — GV — #16 — SPARE 1 — FV — #16 — SPARE 2 — GU — #16 — SPARE 3 — FU — #16 — SPARE 4

NOTE - ALL WIRES TO BE BLK UNLESS OTHERWISE SPECIFIED & BROKEN LINES DENOTE WRG & PARTS OTHER THAN STD & NOT IN STD WIRING.

Figure 39—Cab, Engine, and Chassis Wiring—DH, DI, FH, FI-90

Sheet 1 of 4

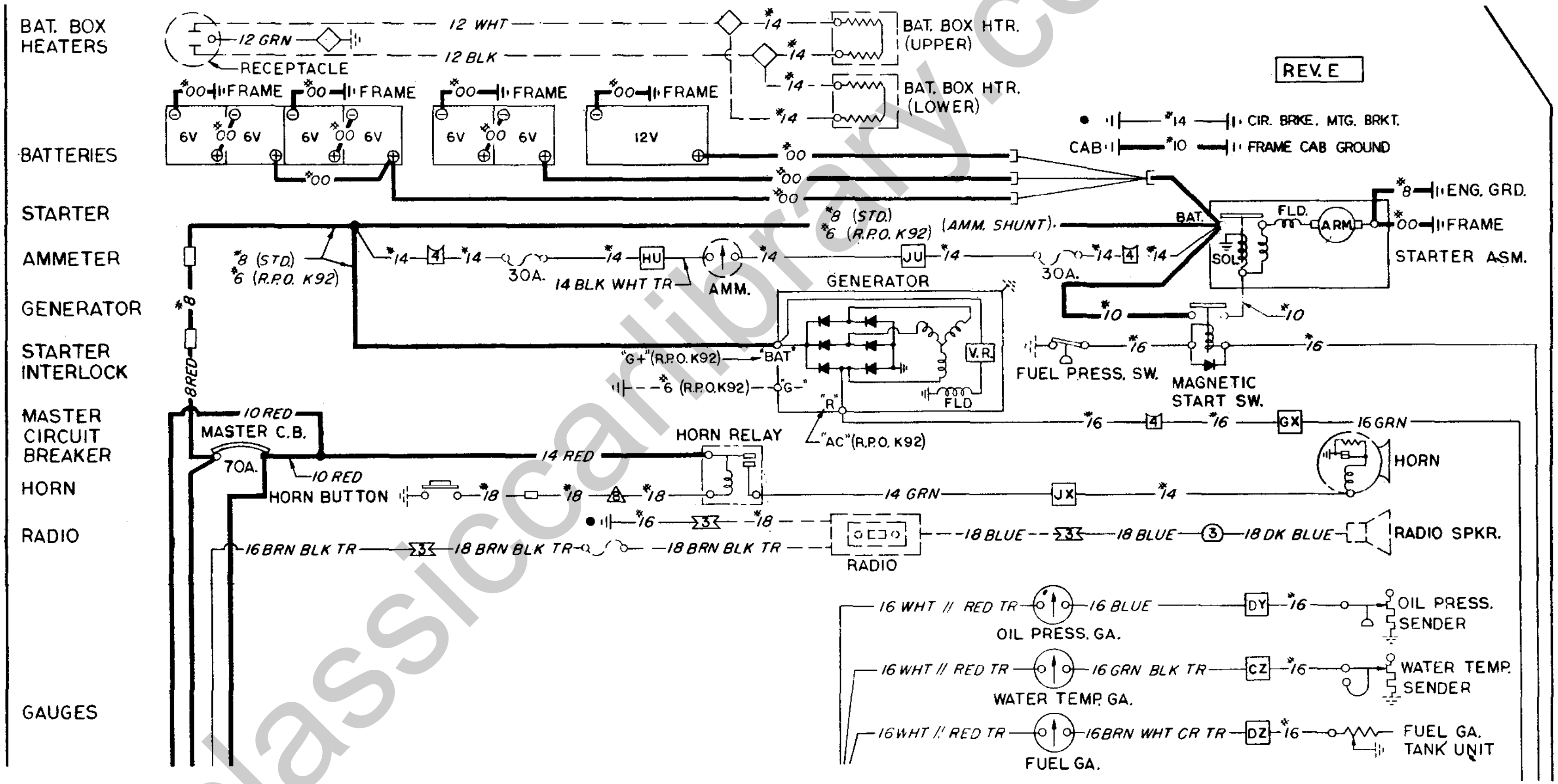

Figure 39—Cab, Engine, and Chassis Wiring—DH, DI, FH, FI-90

Sheet 2 of 4

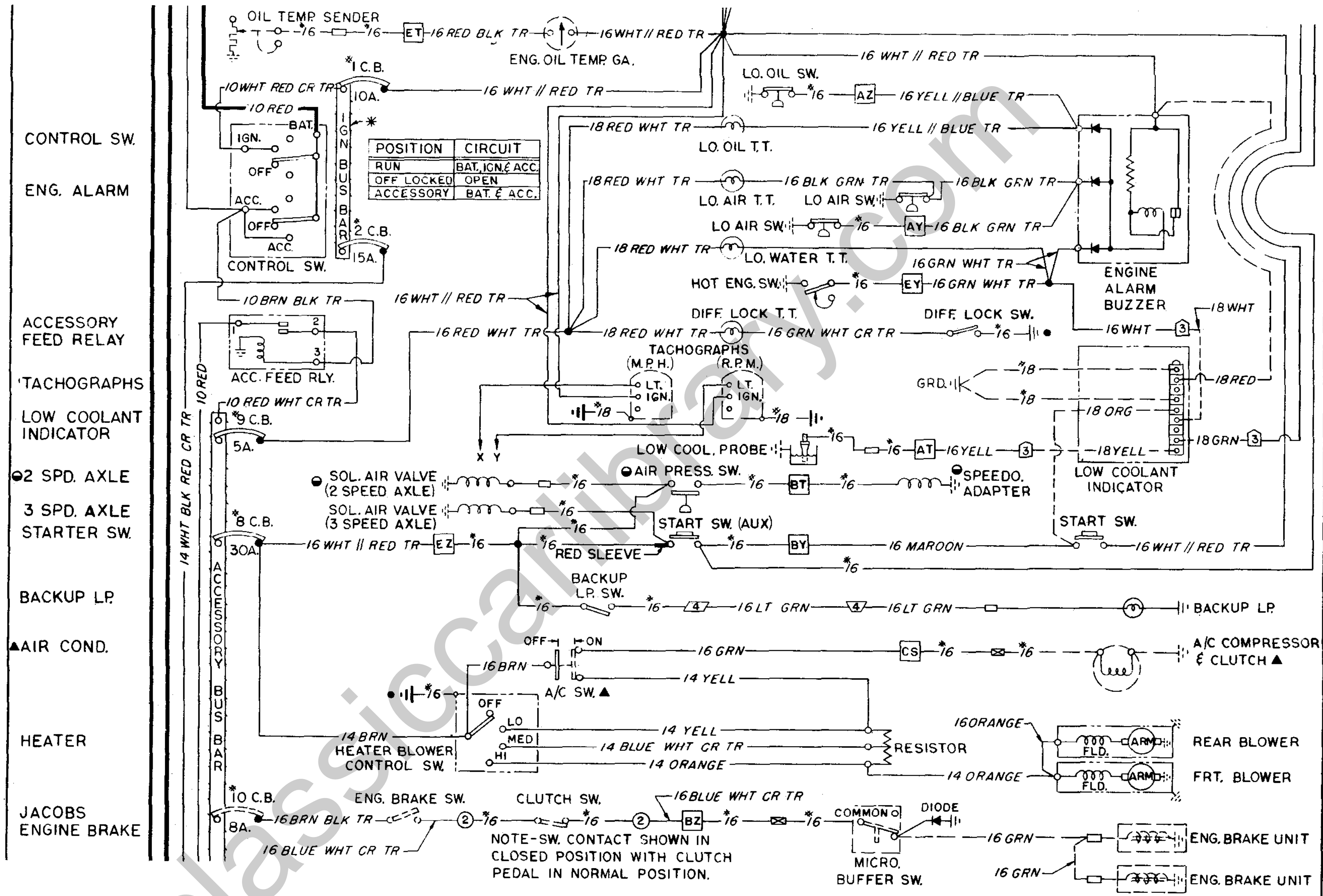

Figure 39—Cab, Engine, and Chassis Wiring—DH, DI, FH, FI-90

Sheet 3 of 4

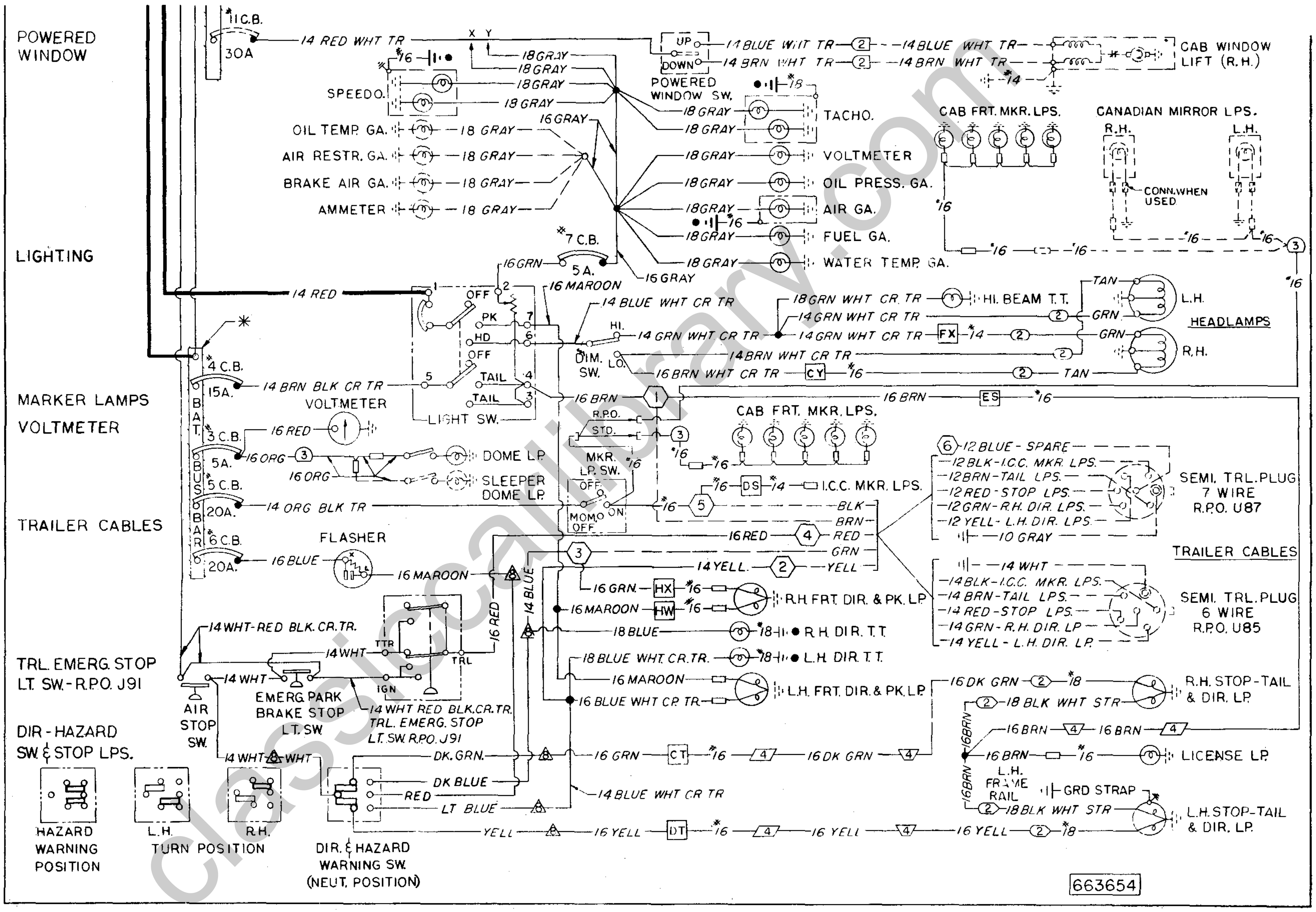

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Figure 39—Cab, Engine, and Chassis Wiring—DH, DI, FH, FI-90

Sheet 4 of 4

LEGEND

SYMBOL	JUNCTION	FUNCTION	LOCATION
(3)	3 WAY CONN.	INSTR. PNL. HARN. TO COOLANT LOSS INDIC. HARN.	AT CONTROL SW. IN CONSOLE COMP'T.
◇	5 POST JCT.	PLUG TO BATTERY BOX HEATER	RADIATOR SHROUD-L.H. SIDE
△	8 WAY CONN.	INSTR. PNL. HARN. TO DIR. & HAZ. WARN. SW. HARN. ASM.	UNDER INSTR. PNL. AT STEERING COL.
(2)	2 WAY CONN.	ENG. HARN. TO R.H. HEADLAMP ASM. INSTR. PNL. HARN. TO L.H. HEADLAMP ASM.	AT HEADLAMP ASM.
(2)	2 WAY CONN.	STOP-TAIL & B/U LP. REAR WRG. HARN. ASM. TO STOP-TAIL LP. ASM.	AT STOP-TAIL LAMPS
3	3 WAY CONN.	RADIO CABLE ASM. TO INSTR. PNL. HARN.	AT RADIO IN CONSOLE COMP'T.
(3)	3 WAY CONN.	INSTR. PNL. HARN. TO CAB MKR. & DOME LP. WRG. HARN. ASM.	UNDER INSTR. PNL.-L.H. SIDE
4	4 WAY CONN.	ENG. HARN. TO STOP-TAIL & B/U LP. FRT. WRG. HARN. ASM. (DC/DN9502 ONLY) STOP-TAIL & B/U LP. REAR WRG. HARN. ASM. (FC/FN9502 ONLY)	L.H. FRAME RAIL
4	4 WAY CONN.	STOP-TAIL & B/U LP. FRT. WRG. HARN. ASM. TO STOP-TAIL & B/U LP. REAR WRG. HARN. ASM.	(DC/DN 9502 ONLY)-L.H. FRAME RAIL
(2)	2 WAY CONN.	INSTR. PNL. HARN. TO CAB WINDOW LIFT WIRE ASM.	R.H. SIDE-UNDER DASH
▭	SINGLE LINE CONN.		RELATED CIRCUITS
○	TERMINAL OR CONN. TERMINATION		RELATED CIRCUITS
●	SPLICE		RELATED CIRCUITS
	LINE FUSE		RELATED CIRCUITS
*	BUS BAR	FEED FOR MULTIPLE CIRCUIT BREAKERS	ELECT. EQUIP. PNL.-CONSOLE COMP'T.
BAT. AUX.	CIRCUIT BREAKER		ELECT. EQUIP. PNL.-CONSOLE COMP'T.
□	32 WAY CONN. (AS THRU JX)	INSTR. PNL. HARN. TO ENG. HARN.	R.H. SIDE-UNDER DASH
⬡	6 POST JCT. (#1 THRU #6)	INSTR. PNL. HARN. TO TRAILER CABLE ASM.	ELECT. EQUIP. PNL.-CONSOLE COMP'T.
(2)	2 WAY CONN.	INSTR. PNL. HARN. TO CLUTCH SW. WIRE ASM.	L.H. SIDE UNDER DASH

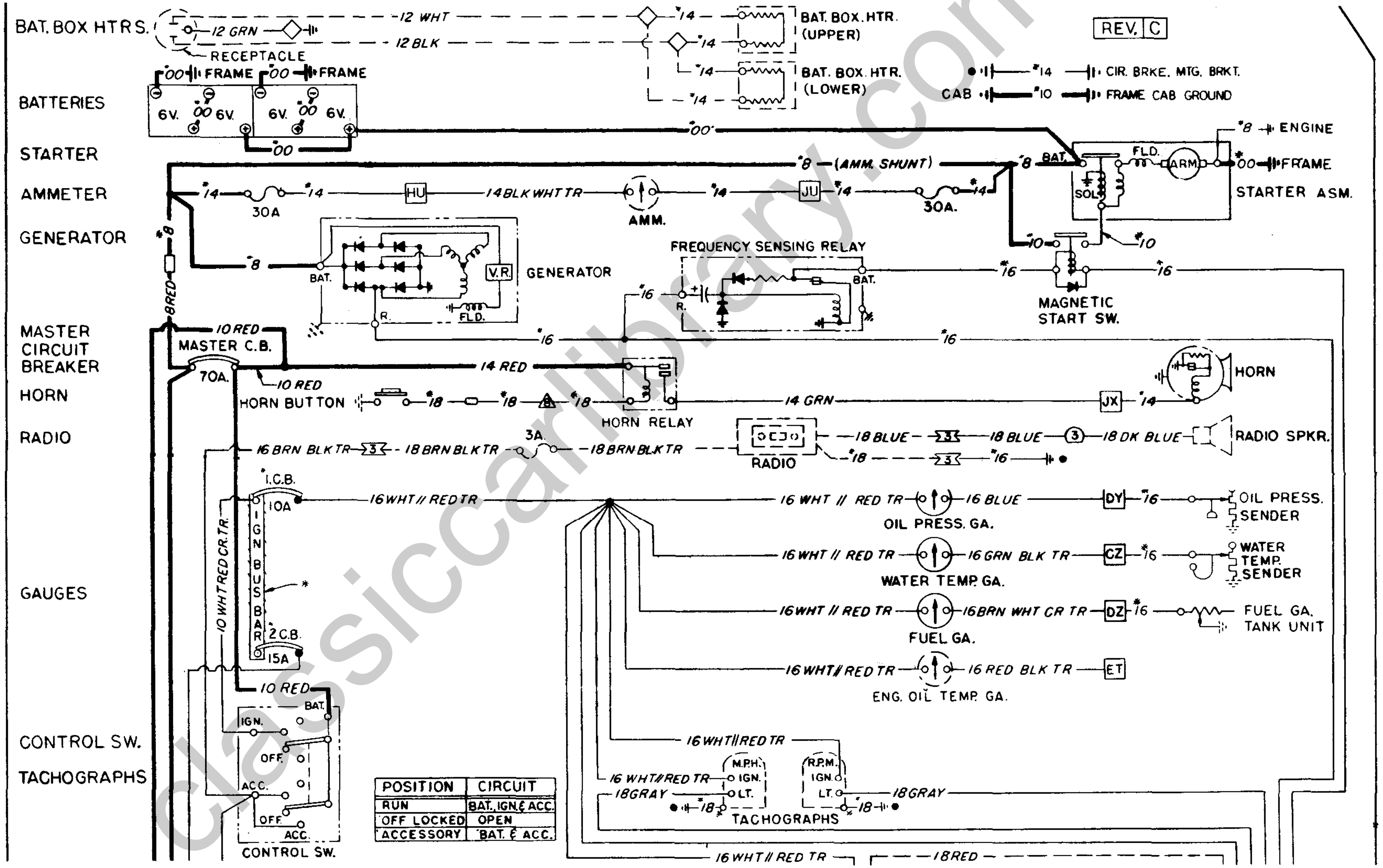
--- BROKEN LINES DENOTE WRG. & PARTS OTHER THAN STD. & NOT IN STD. WRG.

NOTE - ALL WIRES BLACK UNLESS OTHERWISE SPECIFIED.

SPARES - IN ENG. HARN. FROM 32 WAY CONN. TO R.H. FRAME RAIL AT FRT. OF ENGINE

GV	#16	SPARE 1
FV	#16	SPARE 2
GU	#16	SPARE 3
FU	#16	SPARE 4

Figure 40—Cab, Engine, and Chassis Wiring—DC, DN, FC, FN-90
Sheet 1 of 4



POSITION	CIRCUIT
RUN	BAT., IGN. & ACC.
OFF LOCKED	OPEN
ACCESSORY	BAT. & ACC.

Figure 40—Cab, Engine, and Chassis Wiring—DC, DN, FC, FN-90

Sheet 2 of 4

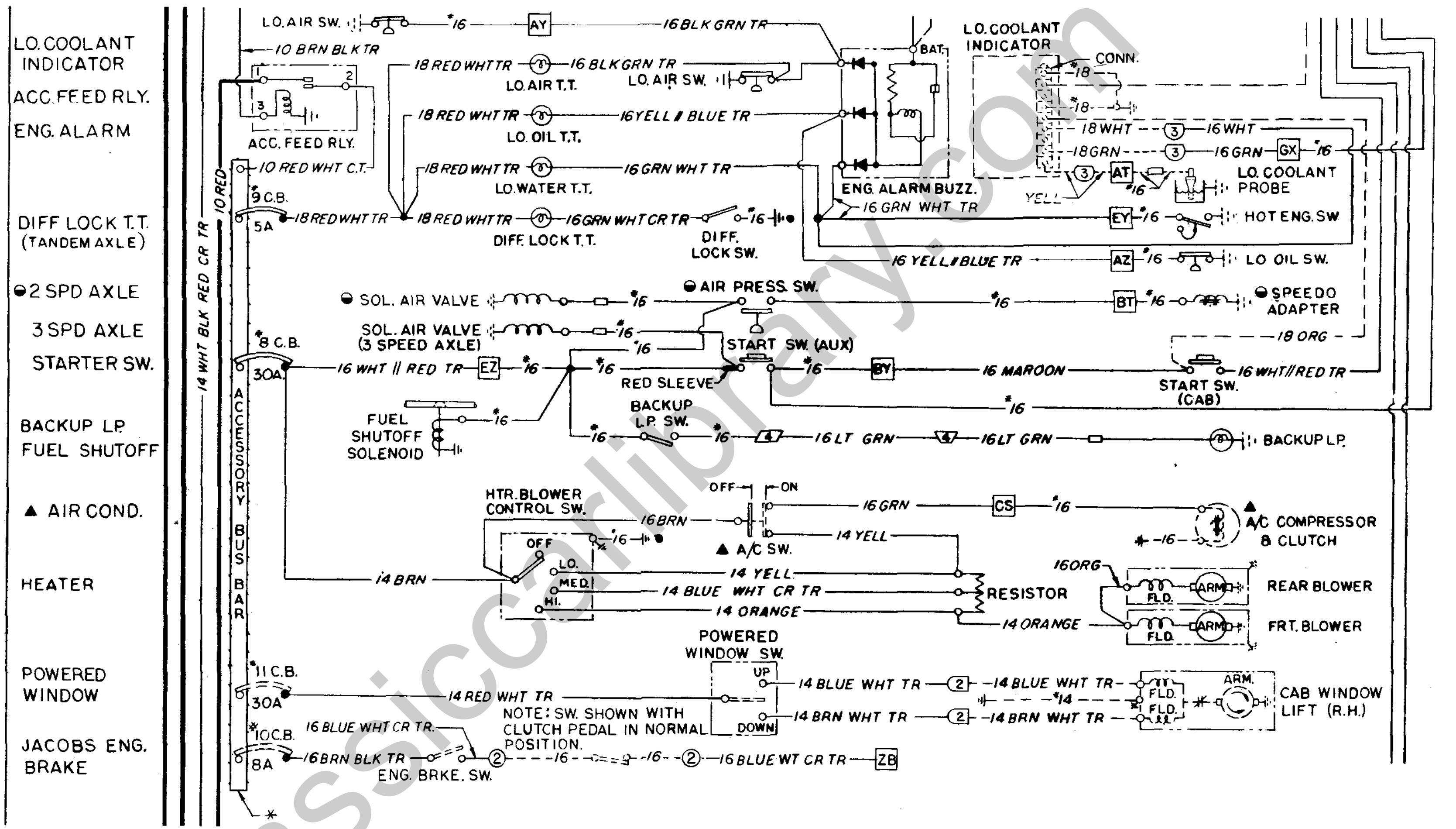


Figure 40—Cab, Engine, and Chassis Wiring—DC, DN, FC, FN-90

Sheet 3 of 4

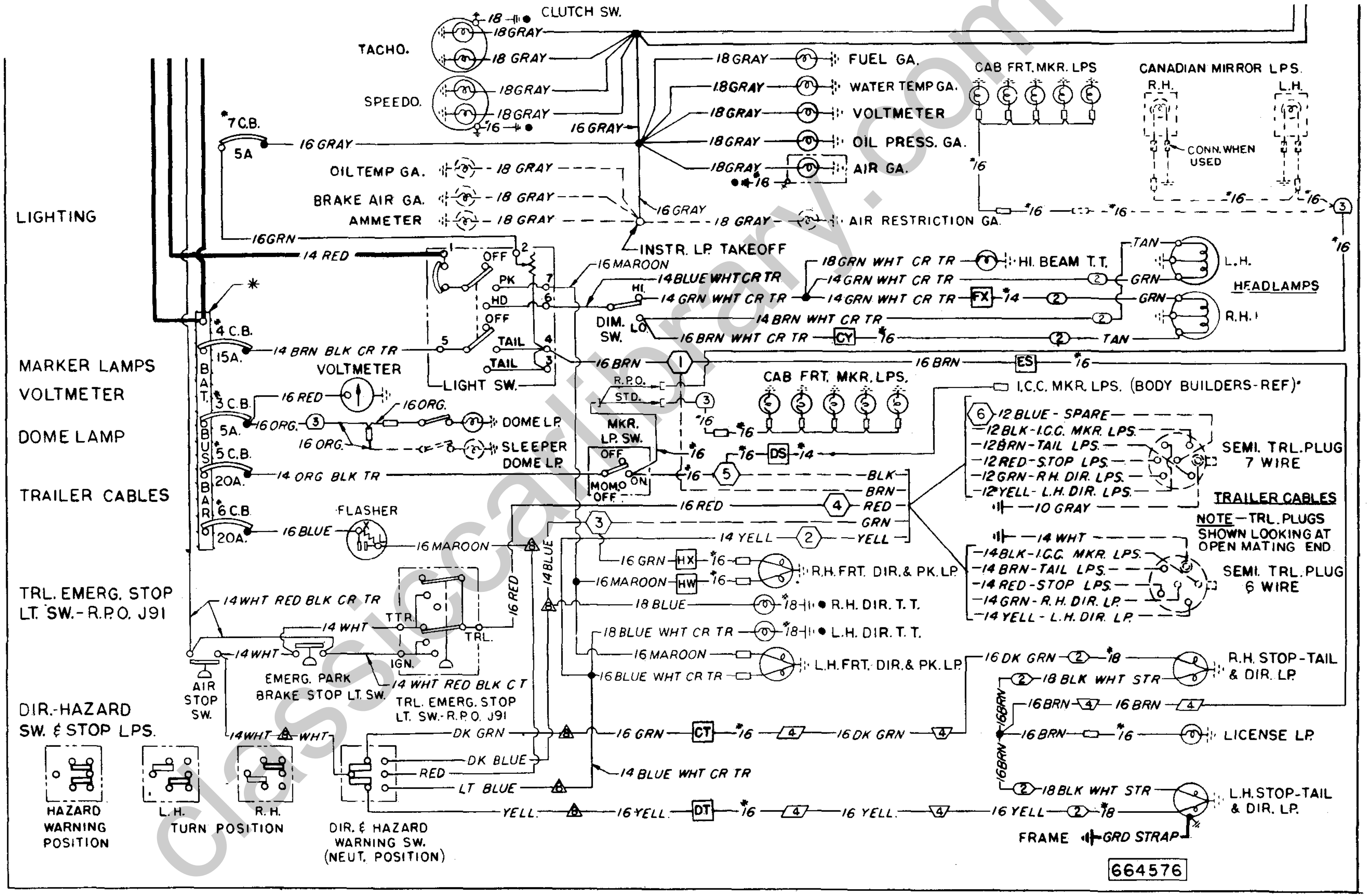


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Figure 40—Cab, Engine, and Chassis Wiring—DC, DN, FC, FN-90

Sheet 4 of 4

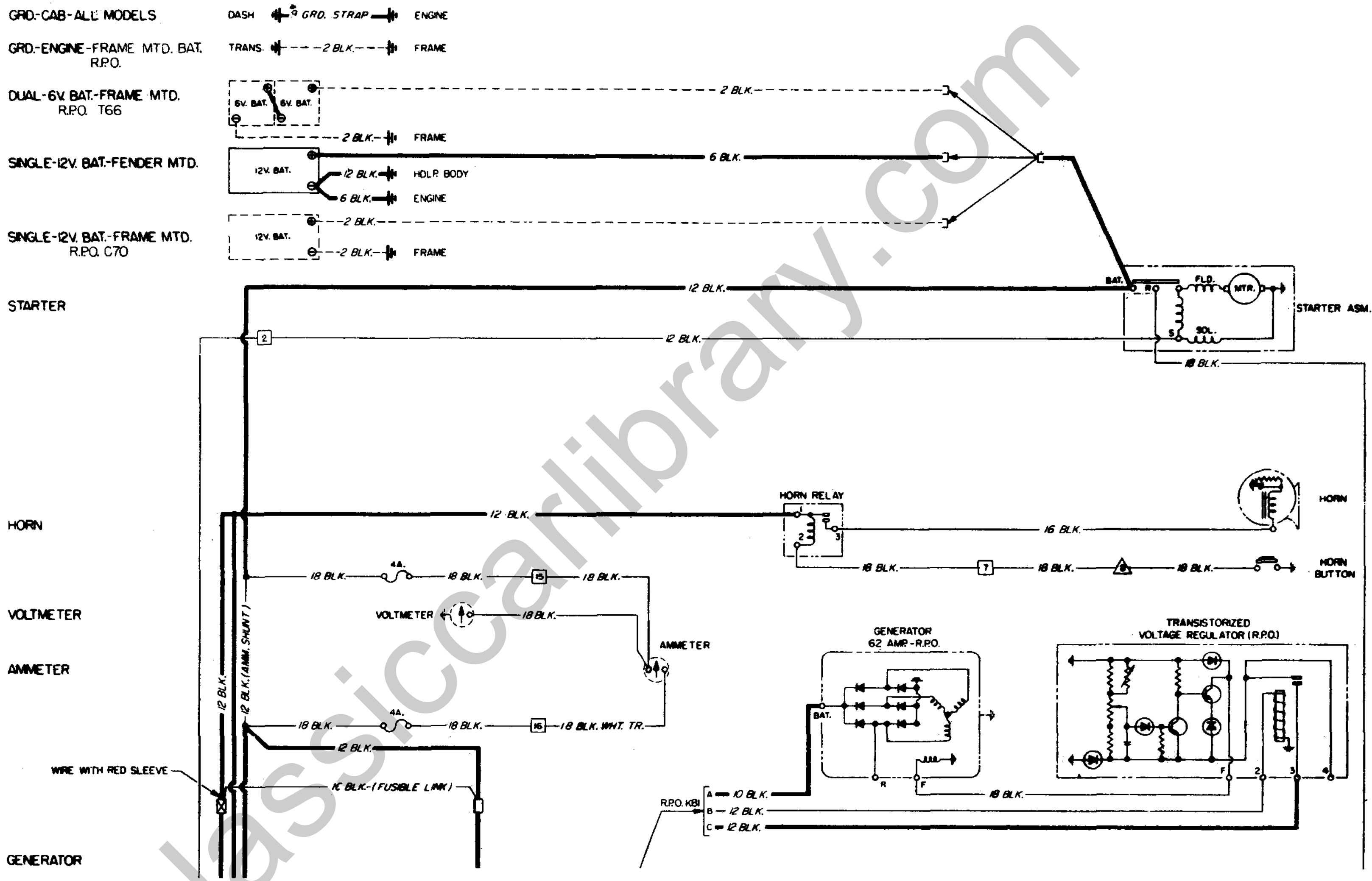

Figure 41—Cab, Engine, and Chassis Wiring—HM, JM-80
Sheet 1 of 6

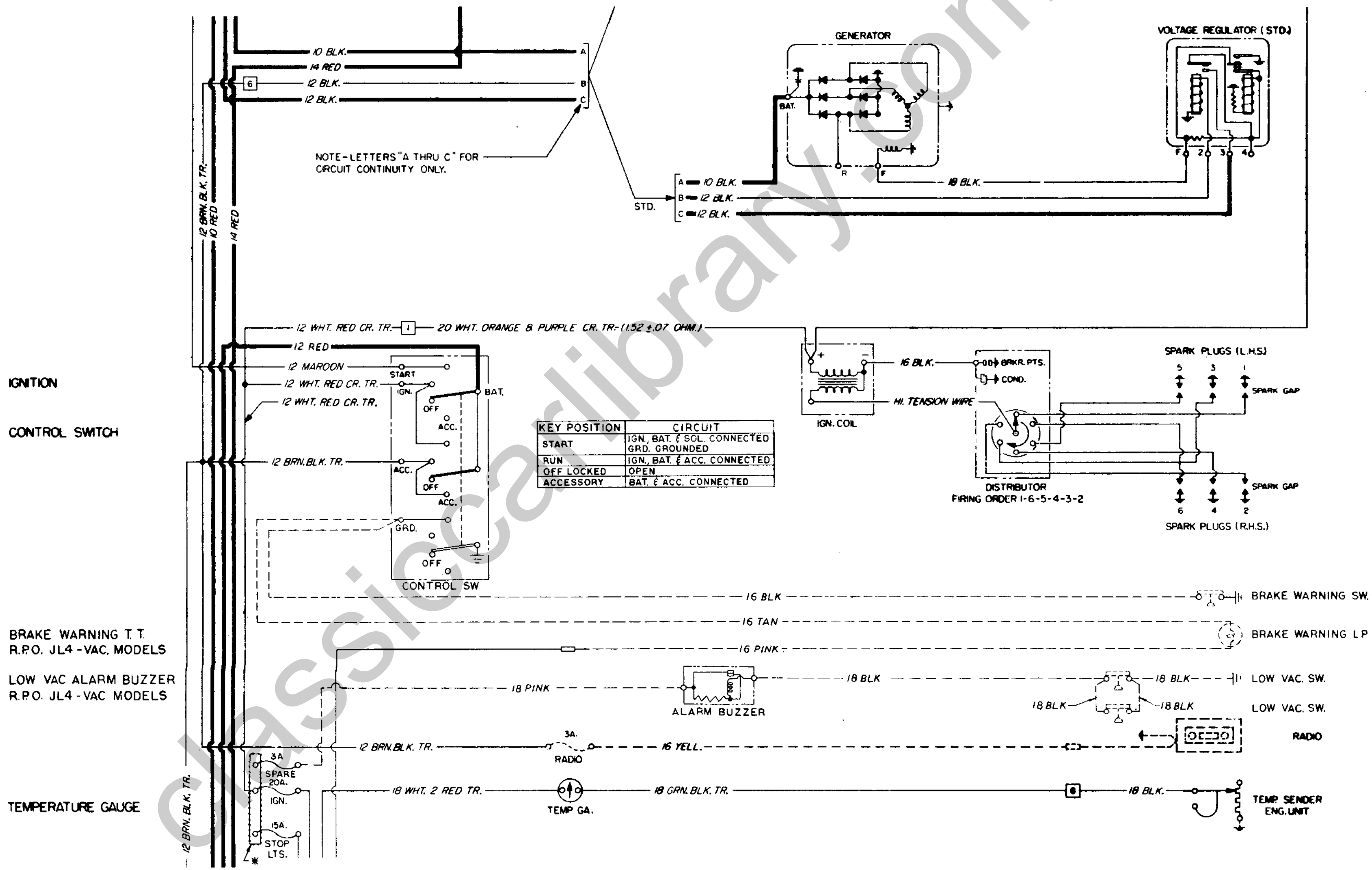

Figure 41—Cab, Engine, and Chassis Wiring—HM, JM-80

Sheet 2 of 6

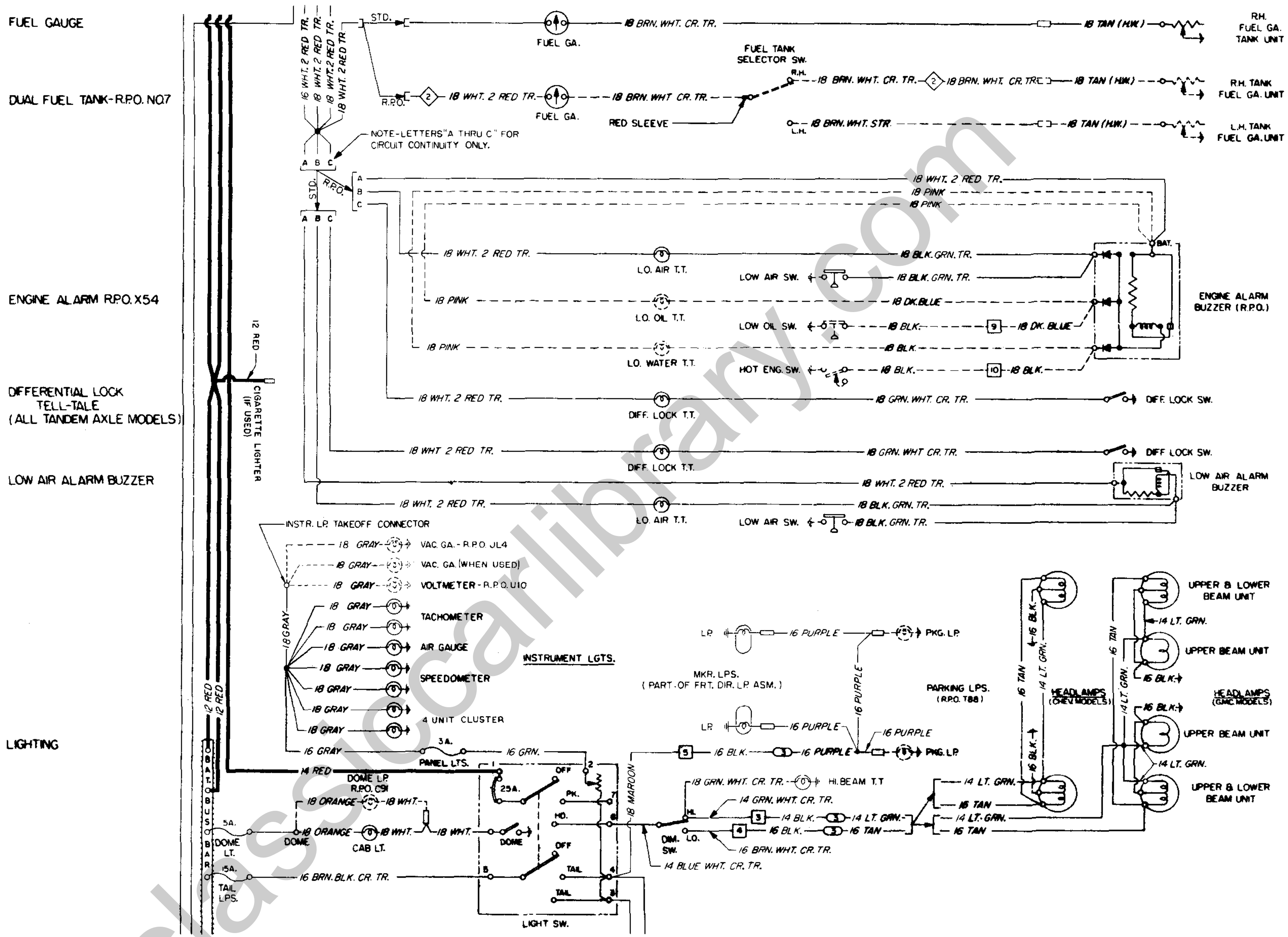

Figure 41—Cab, Engine, and Chassis Wiring—HM, JM-80
Sheet 3 of 6

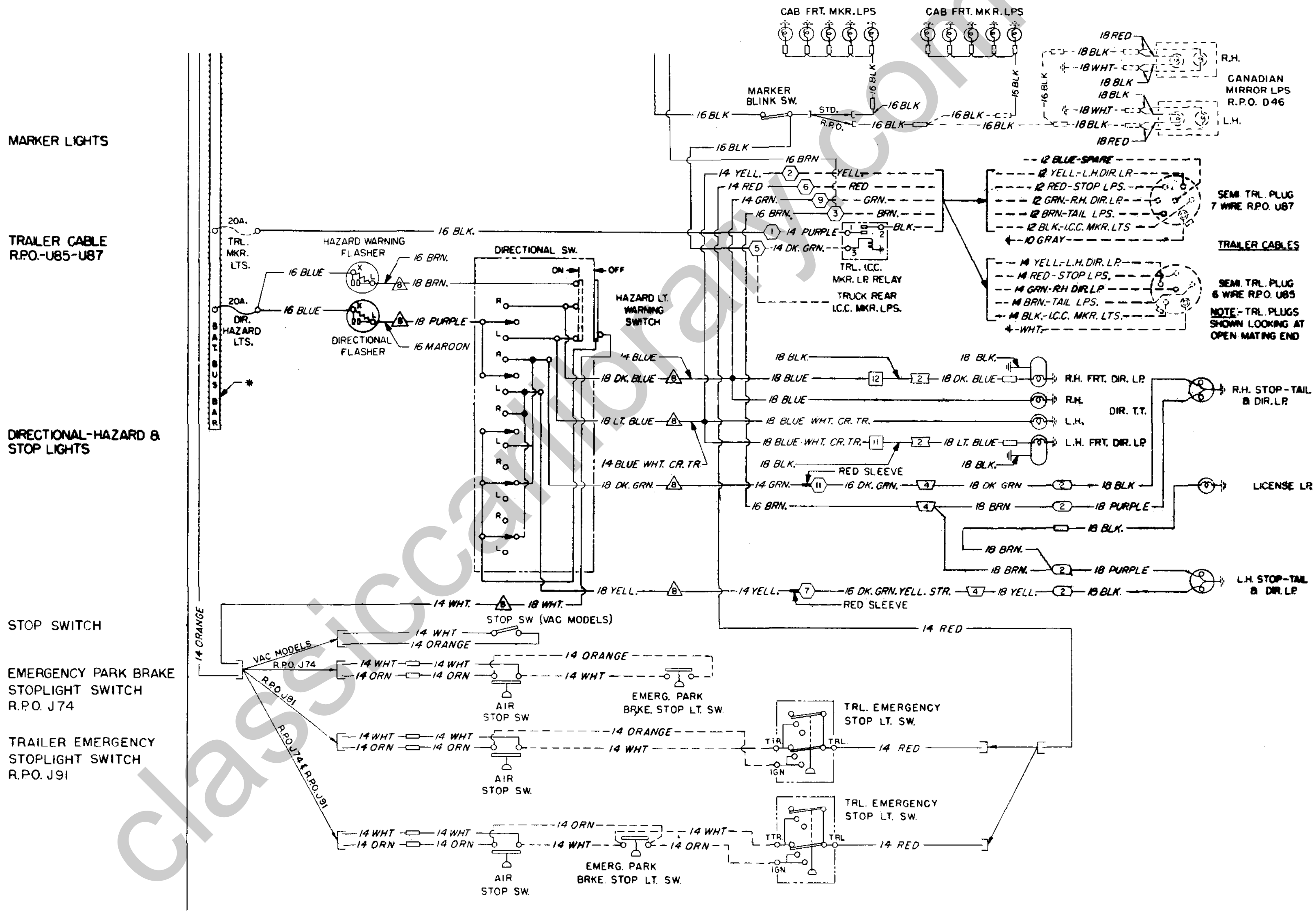

Figure 41—Cab, Engine, and Chassis Wiring—HM, JM-80

Sheet 4 of 6

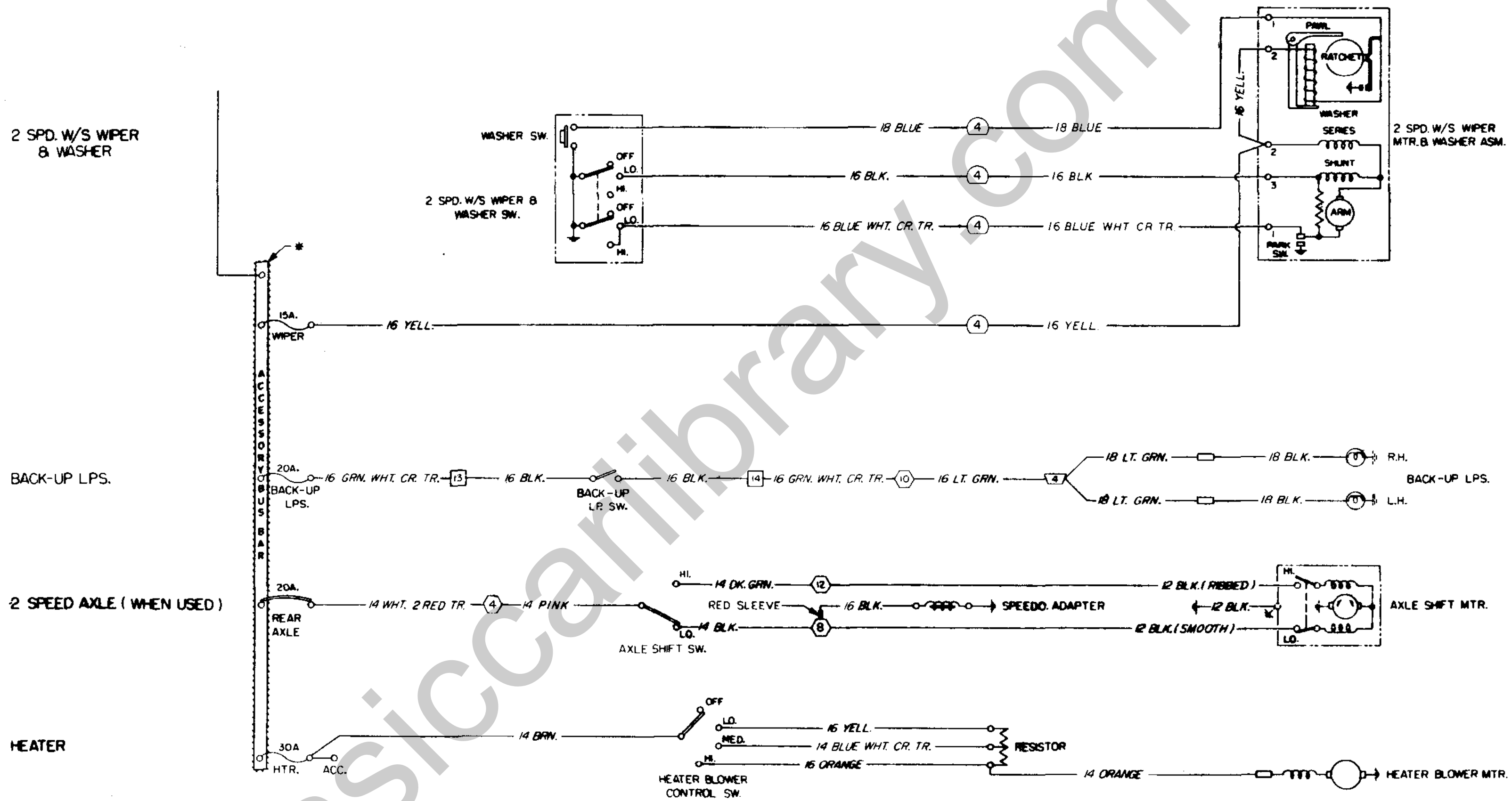

Figure 41—Cab, Engine, and Chassis Wiring—HM, JM-80
Sheet 5 of 6

CIRCUIT IDENTIFICATION

LEGEND

SYMBOL	JUNCTION	FUNCTION	LOCATION
	4 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO W/S WIPER MTR. & WASHER HARN. ASM.	AT DASH PANEL - BEHIND GLOVE BOX COMP'T
	TERM. CAVITY (*1 THRU *16) / TERM. JCT. STUD-INNER (L.H.) / TERM. JCT. STUD-OUTER (R.H.) — 18 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO ENG. HARN.	ENG. COMPARTMENT-DASH PANEL-UPPER R.H. SIDE
	8 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO DIR. SW. HARN.	UNDER INSTR. PANEL AT STEERING COLUMN
	2 WAY MULTIPLE CONNECTOR	FUEL TANK SELECTOR SW. WIRE TO FUEL GAUGE TO INSTR. PANEL HARN.	UNDER INSTR. PANEL AT FUEL GA.
	3 WAY MULTIPLE CONNECTOR / 2 WAY MULTIPLE CONNECTOR	ENG. HARN. TO HD. LP. & PARKING LP. HARN.	AT HEADLAMP ASM.
	4 WAY MULTIPLE CONNECTOR	STOP & TAIL LP. FRT. EXT. HARN. TO REAR STOP & TAIL LP. HARN.	L.H. FRAME RAIL (REAR)
	2 WAY MULTIPLE CONNECTOR	REAR STOP & TAIL LP. HARN. TO STOP & TAIL LP. ASM.	AT STOP & TAIL LP. ASM.
	SINGLE LINE CONNECTOR	RELATED CIRCUITS	
	12 POST JCT. BLOCK (*1 THRU *12)	INSTR. PANEL HARN. TO — STOP & TAIL LP. FRT. EXT. HARN. & FUEL TANK WIRE / AXLE SHIFT MTR. SW. CABLE, AXLE SHIFT MTR. CABLE (WHEN USED) / TRAILER CABLE	INSIDE CAB-R.H. REAR SIDE
	LINE FUSE	CIRCUIT PROTECTOR FOR AMMETER (WHEN USED) & VOLTMETER	AT 18 WAY MULTIPLE CONNECTOR
	TERM. OR CONNECTOR TERMINATION / SPLICE	RELATED CIRCUITS	
	FUSE / CIRCUIT BREAKER	FUSE BLOCK	IN GLOVE BOX COMPARTMENT

---- BROKEN LINES & SPECIFIED R.P.O. DENOTE WRG. & PARTS OTHER THAN STD. & NOT IN STD. WRG. HARN. ASM'S.

* BUS BAR PART OF FUSE BLOCK-FUSE BLOCK PART OF INSTR. PANEL HARN. ASM.

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Figure 41—Cab, Engine, and Chassis Wiring—HM, JM-80
Sheet 6 of 6

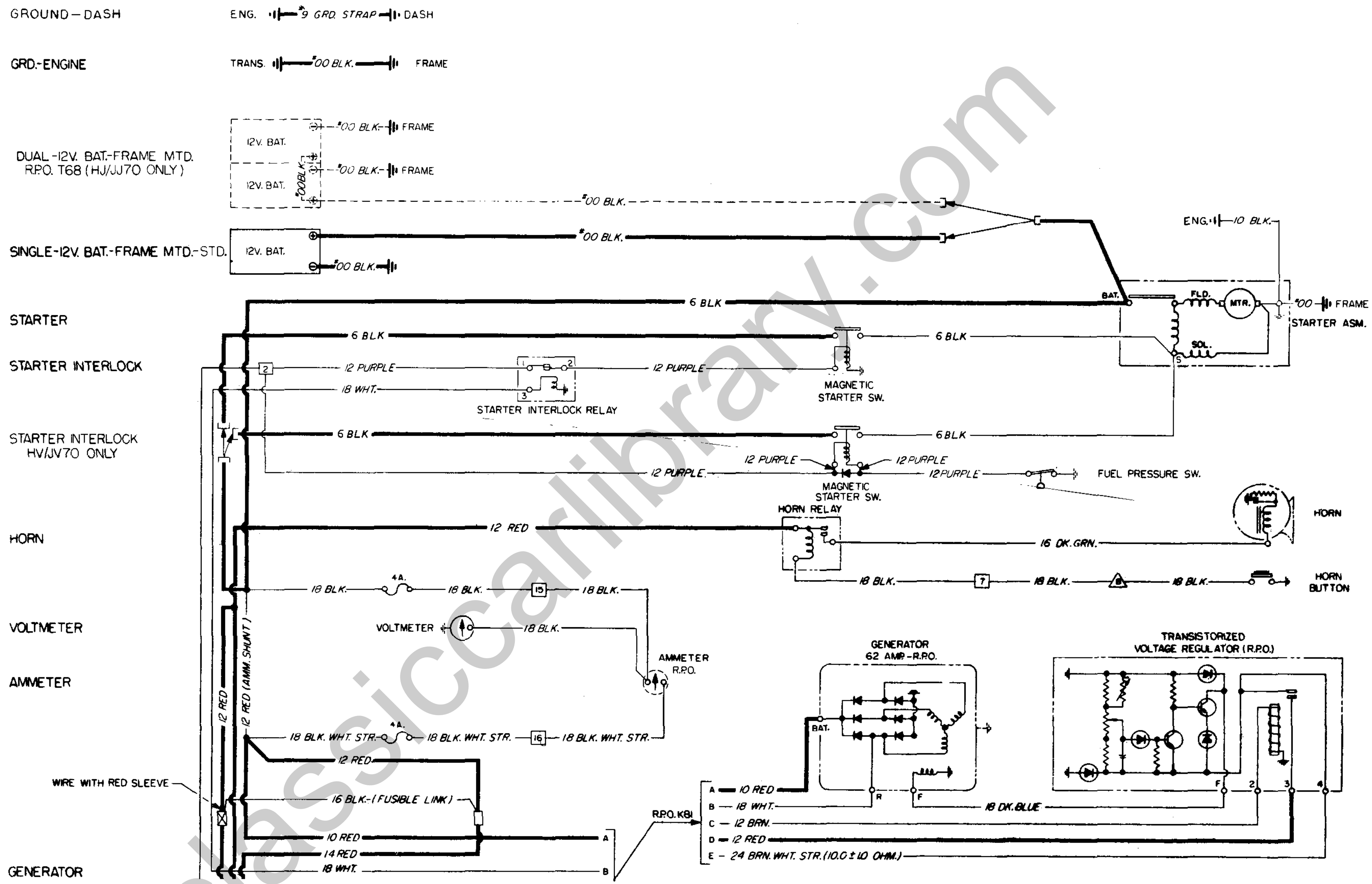

Figure 42—Cab, Engine, and Chassis Wiring—HV, JV-70

Sheet 1 of 6

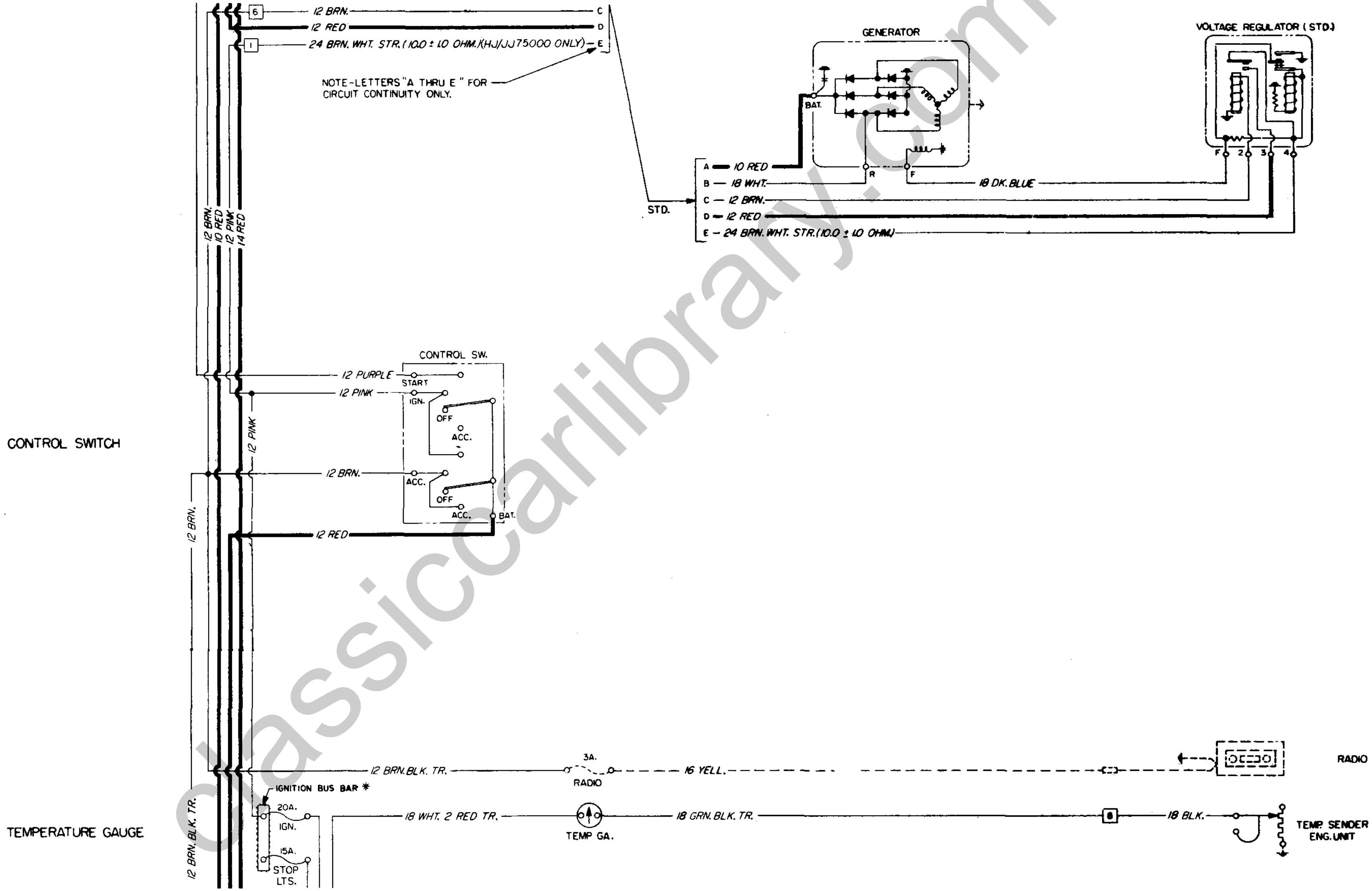

Figure 42—Cab, Engine, and Chassis Wiring—HV, JV-70
Sheet 2 of 6

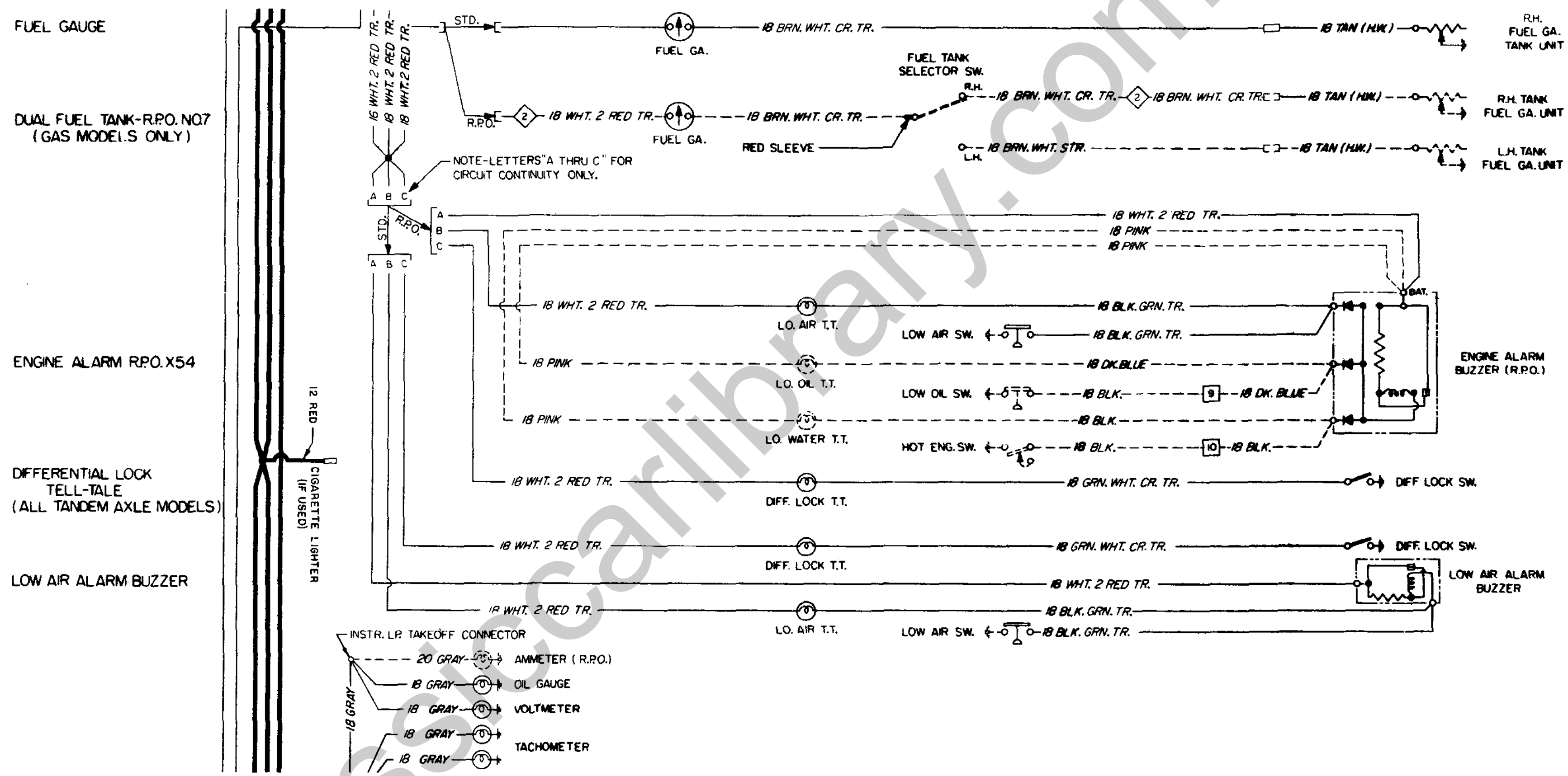

Figure 42—Cab, Engine, and Chassis Wiring—HV, JV-70
Sheet 3 of 6

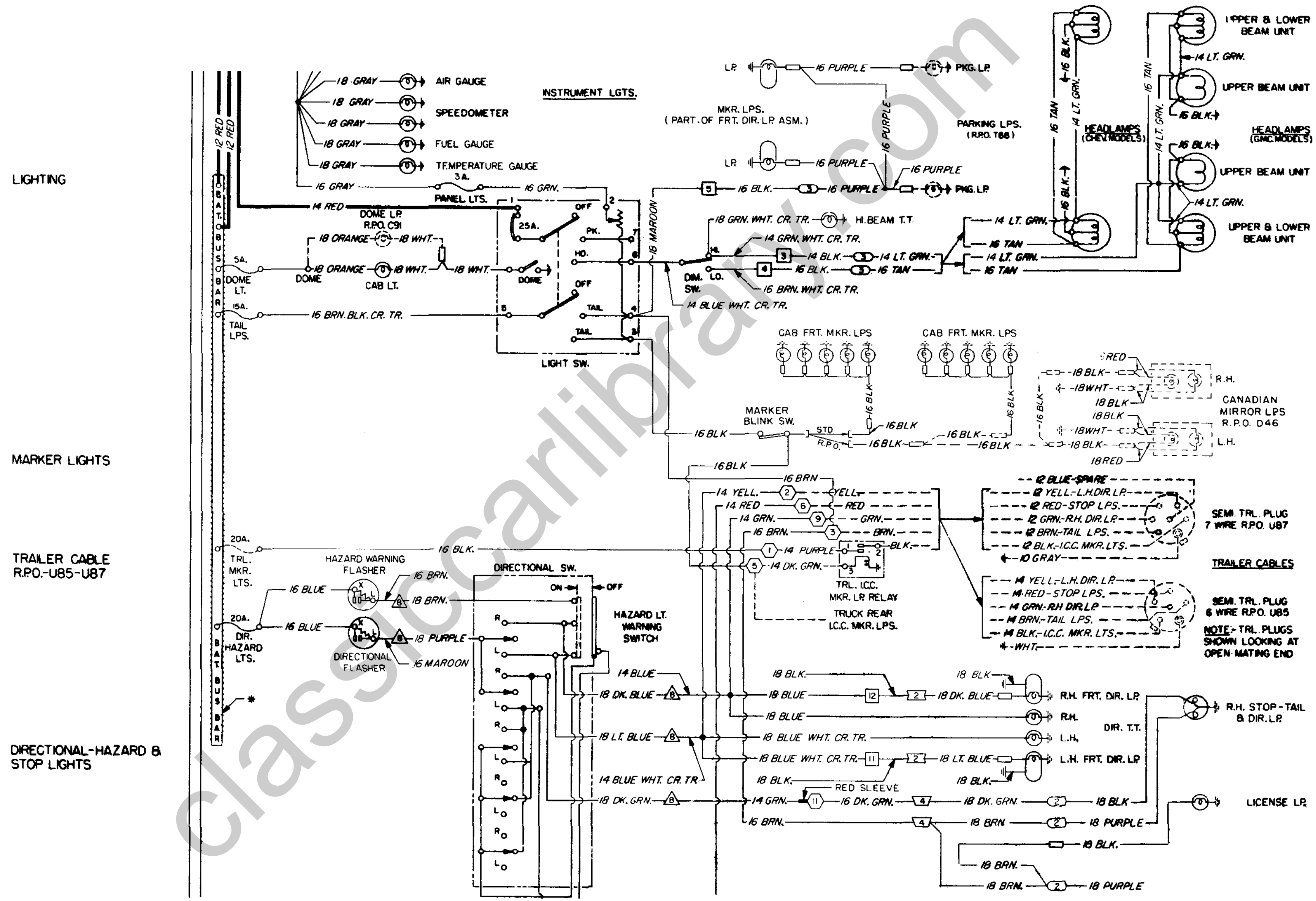

Figure 42—Cab, Engine, and Chassis Wiring—HV, JV-70
Sheet 4 of 6

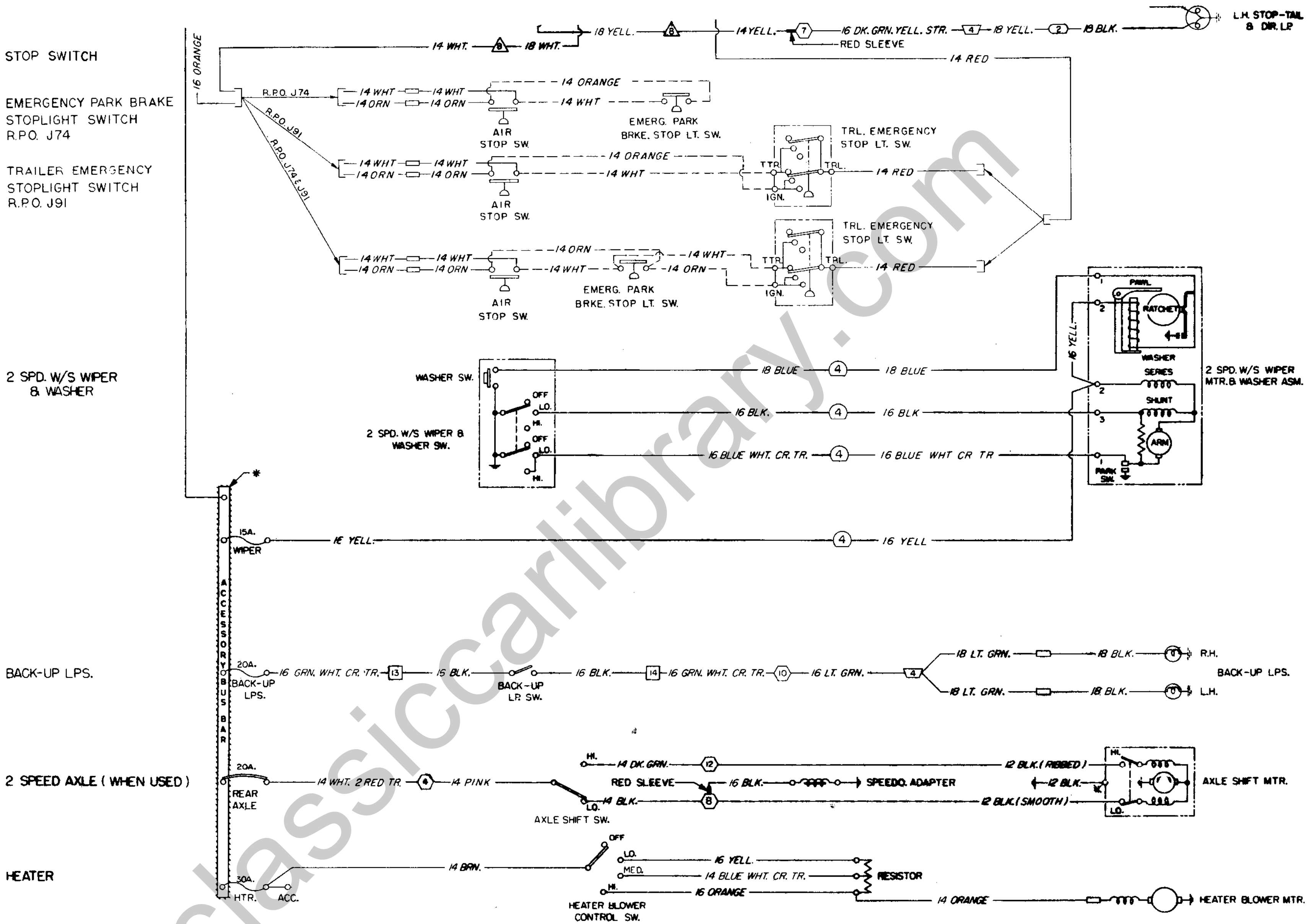

Figure 42—Cab, Engine, and Chassis Wiring—HV, JV-70
Sheet 5 of 6

CIRCUIT IDENTIFICATION

LEGEND

SYMBOL	JUNCTION	FUNCTION	LOCATION
4	4 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO W/S WIPER MTR. & WASHER HARN. ASM.	AT DASH PANEL – BEHIND GLOVE BOX COMP'T.
	TERM. CAVITY ("1 THRU "16) — 18 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO ENG. HARN.	ENG. COMPARTMENT-DASH PANEL-UPPER R.H. SIDE
	TERM. JCT. STUD-INNER (L.H.) — 18 WAY MULTIPLE CONNECTOR		
	TERM. JCT. STUD-OUTER (R.H.) — 18 WAY MULTIPLE CONNECTOR		
8	8 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO DIR. SW. HARN.	UNDER INSTR. PANEL AT STEERING COLUMN
2	2 WAY MULTIPLE CONNECTOR	FUEL TANK SELECTOR SW. WIRE TO FUEL GAUGE TO INSTR. PANEL HARN.	UNDER INSTR. PANEL AT FUEL GA.
3	3 WAY MULTIPLE CONNECTOR	ENG. HARN. TO HD. LP. & PARKING LP. HARN.	AT HEADLAMP ASM.
2	2 WAY MULTIPLE CONNECTOR		
4	4 WAY MULTIPLE CONNECTOR	STOP & TAIL LP. FRT. EXT. HARN. TO REAR STOP & TAIL LP. HARN.	L.H. FRAME RAIL (REAR)
2	2 WAY MULTIPLE CONNECTOR	REAR STOP & TAIL LP. HARN. TO STOP & TAIL LP. ASM.	AT STOP & TAIL LP. ASM.
	SINGLE LINE CONNECTOR	RELATED CIRCUITS	
	12 POST JCT. BLOCK ("1 THRU "12)	INSTR. PANEL HARN. TO STOP & TAIL LP. FRT. EXT. HARN. & FUEL TANK WIRE; AXLE SHIFT MTR. SW. CABLE (WHEN USED); AXLE SHIFT MTR. CABLE (WHEN USED); TRAILER CABLE	INSIDE CAB-R.H. REAR SIDE
	LINE FUSE	CIRCUIT PROTECTOR FOR AMMETER (WHEN USED) & VOLTMETER	AT 18 WAY MULTIPLE CONNECTOR
	TERM. OR CONNECTOR TERMINATION	RELATED CIRCUITS	
	SPLICE		
	FUSE	FUSE BLOCK	IN GLOVE BOX COMPARTMENT
	CIRCUIT BREAKER		
- - - -	BROKEN LINES & SPECIFIED R.P.O. DENOTE WRG. & PARTS OTHER THAN STD. & NOT IN STD. WRG. HARN. ASM'S		
*	BUS BAR PART OF FUSE BLOCK-FUSE BLOCK PART OF INSTR. PANEL HARN. ASM.		

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Figure 42—Cab, Engine, and Chassis Wiring—HV, JV-70
Sheet 6 of 6

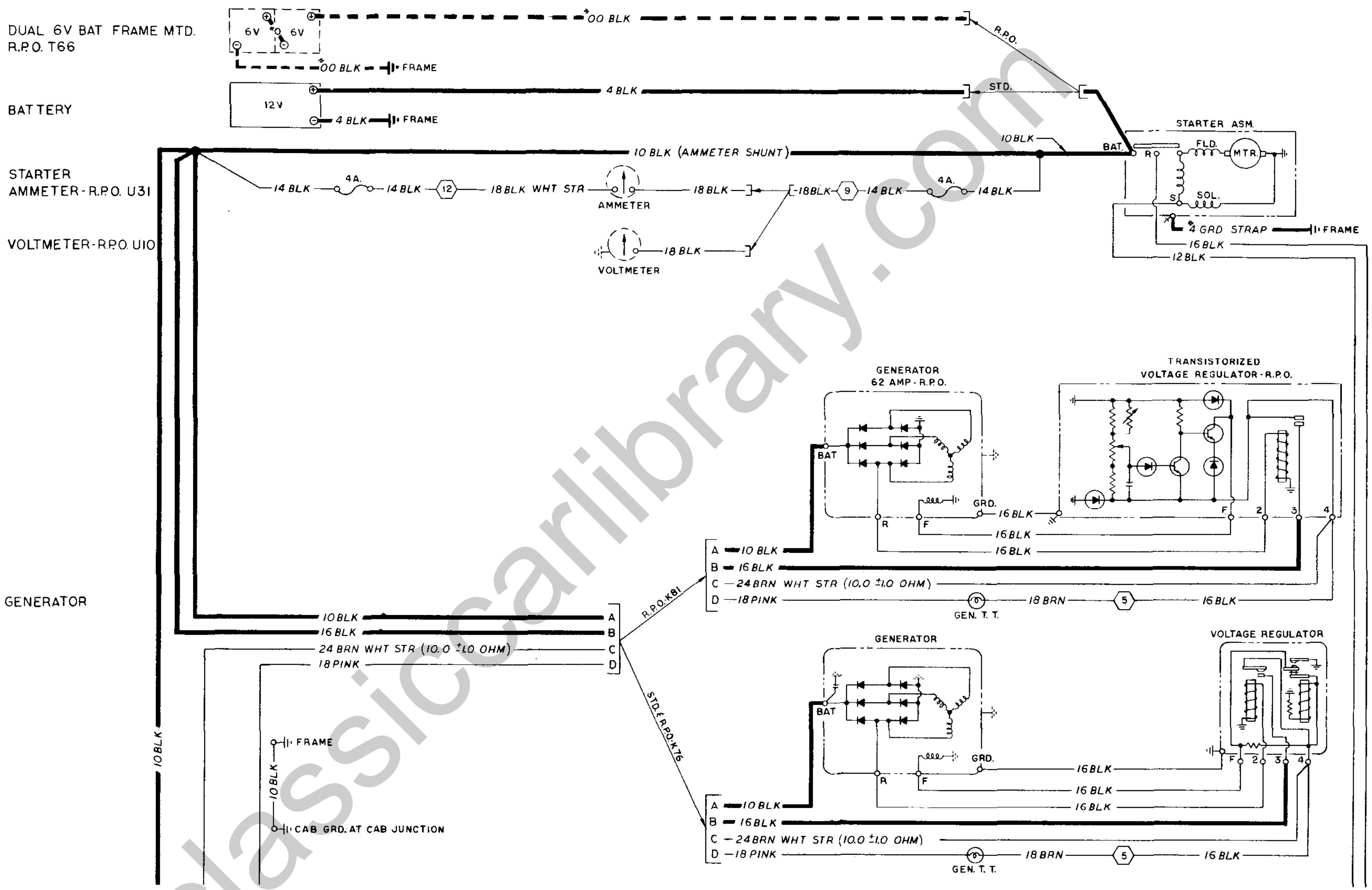

Figure 43—Cab, Engine, and Chassis Wiring—TM80
Sheet 1 of 6

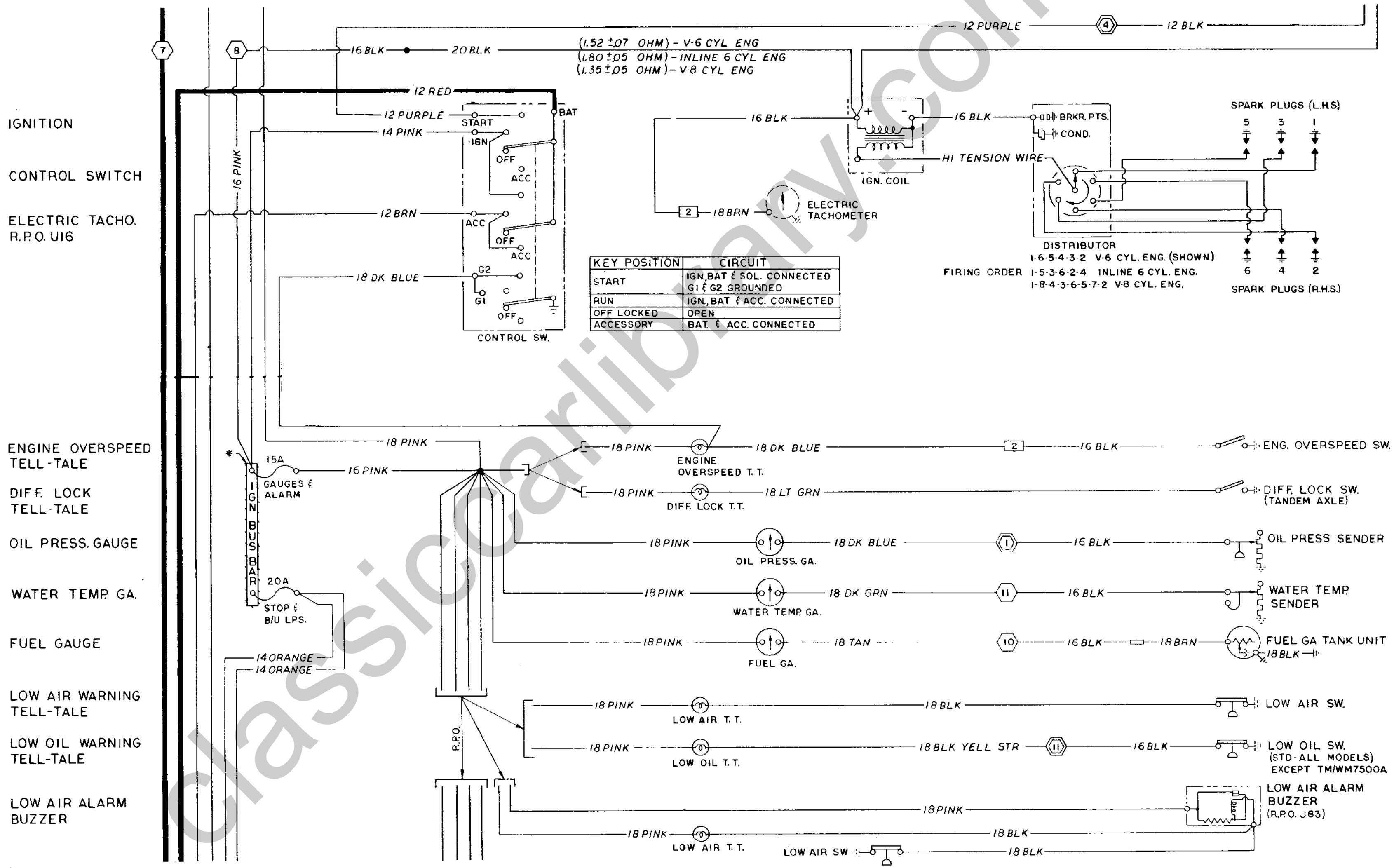

Figure 43—Cab, Engine, and Chassis Wiring—TM80
Sheet 2 of 6

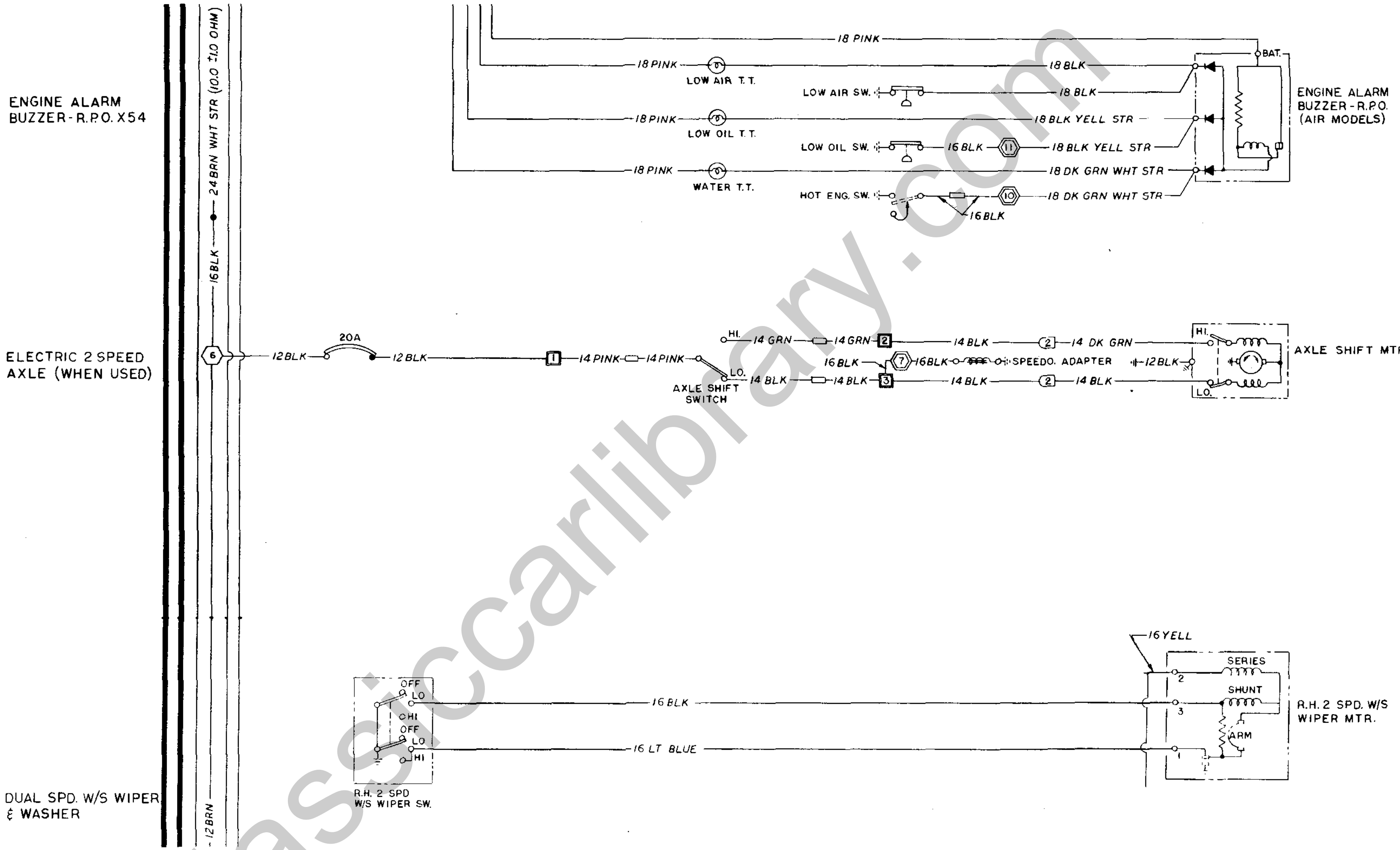

Figure 43—Cab, Engine, and Chassis Wiring—TM80
Sheet 3 of 6

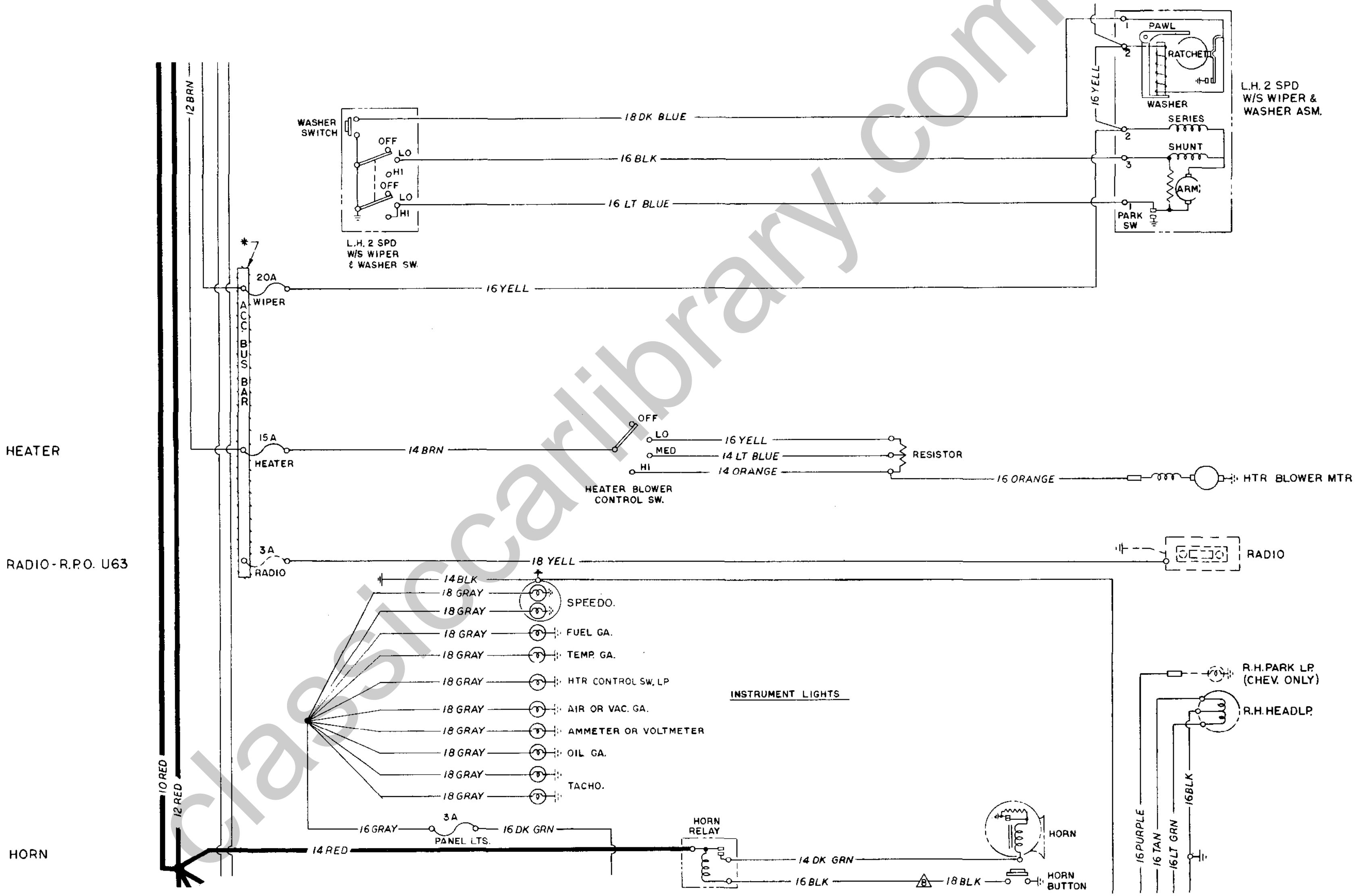

Figure 43—Cab, Engine, and Chassis Wiring—TM80

Sheet 4 of 6

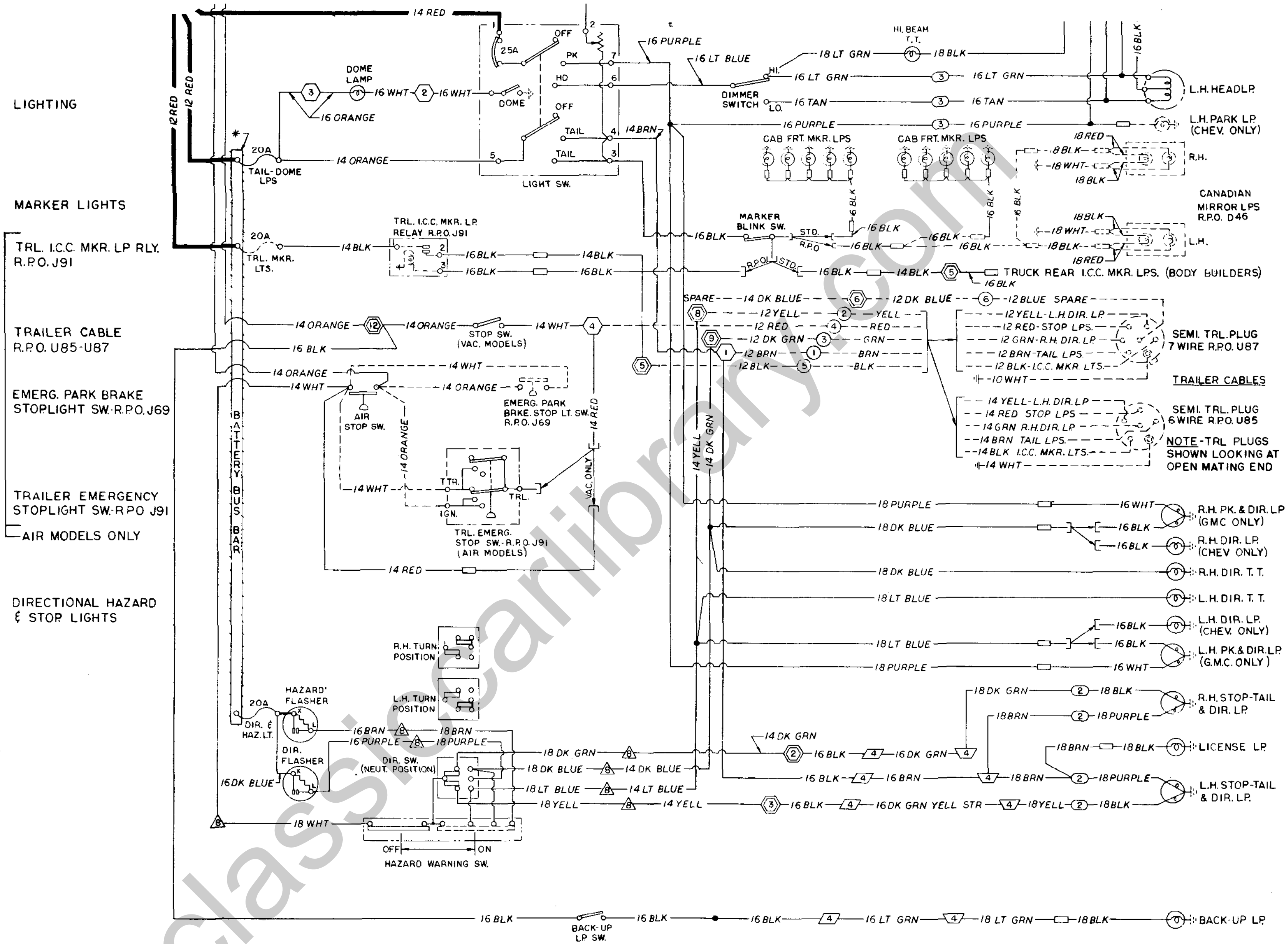

Figure 43—Cab, Engine, and Chassis Wiring—TM80
Sheet 5 of 6

CIRCUIT IDENTIFICATION

LEGEND

SYMBOL	JUNCTION	FUNCTION	LOCATION
	3 POST JCT BLOCK (*1 THRU *3)	ENG. HARN. TO SHIFT SW. JCT. CABLE TO AXLE SHIFT SW.	ON CONTROL ISLAND PNL SUP'T FRT SILL BRK'T
	12 POST JCT. BLOCK (*1 THRU *12) L.H.	INSTR. PANEL HARN. TO ENG. HARN. DOME LP. WIRE ASM. & TRL. WRG. HARN.	CAB JCT. BELOW FLOOR AT L.H. FRT. STEP RISER
	12 POST JCT. BLOCK (*1 THRU *12) R.H.-WIRES WITH RED SLEEVE		
	6 POST JCT. BLOCK (*1 THRU *6)	TRL. WRG. HARN. TO TRL. CABLE ASM.	UNDER CAB AT CAB REAR
8	8 WAY MULTIPLE CONNECTOR	DIRECT. SW. ASM. TO INSTR. PNL. HARN.	UNDER INSTR. PANEL AT STEERING COLUMN
3	3 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO HDLP. & PARK LP. HARN.	BELOW FLOOR AT L.H. HDLP. ASM.
4	4 WAY MULTIPLE CONNECTOR	ENG. HARN. TO STOP-TAIL LP. FRT. EXT. HARN.	L.H. FRAME RAIL AT BACK OF CAB
4	4 WAY MULTIPLE CONNECTOR	STOP-TAIL LP FRT EXT HARN. TO REAR STOP-TAIL LP. HARN.	L.H. FRAME RAIL AT REAR AXLE
2	2 WAY MULTIPLE CONNECTOR	REAR STOP-TAIL LP HARN. TO STOP-TAIL LP ASM.	AT STOP-TAIL LP. ASM.
2	2 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO ENG. HARN.	CAB JCT BELOW FLOOR AT L.H. FRT. STEP RISER (TS & TE MODELS ONLY)
2	2 WAY MULTIPLE CONNECTOR	ENG. HARN. TO AXLE SHIFT MTR. CABLE	L.H. FRAME AT BACK OF CAB
	FUSE		FUSE BLOCK-INSIDE CAB L.H. SIDE COWL PANEL
BAT. AUX.	CIRCUIT BREAKER		CAB. JCT. BELOW FLOOR AT L.H. FRT. STEP RISER
	SINGLE LINE CONNECTOR		RELATED CIRCUITS
○	TERMINAL OR CONNECTOR TERMINATION		RELATED CIRCUITS
●	SPLICE		RELATED CIRCUITS
	LINE FUSE		RELATED CIRCUITS

---- BROKEN LINES & SPECIFIED R.P.O. DENOTE WRG. & PARTS OTHER THAN STD. & NOT IN STD. WRG. HARN. ASM.

* BUS BAR PART OF FUSE BLOCK - FUSE BLOCK PART OF INSTR. PANEL HARN. ASM.

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Figure 43—Cab, Engine, and Chassis Wiring—TM80
Sheet 6 of 6

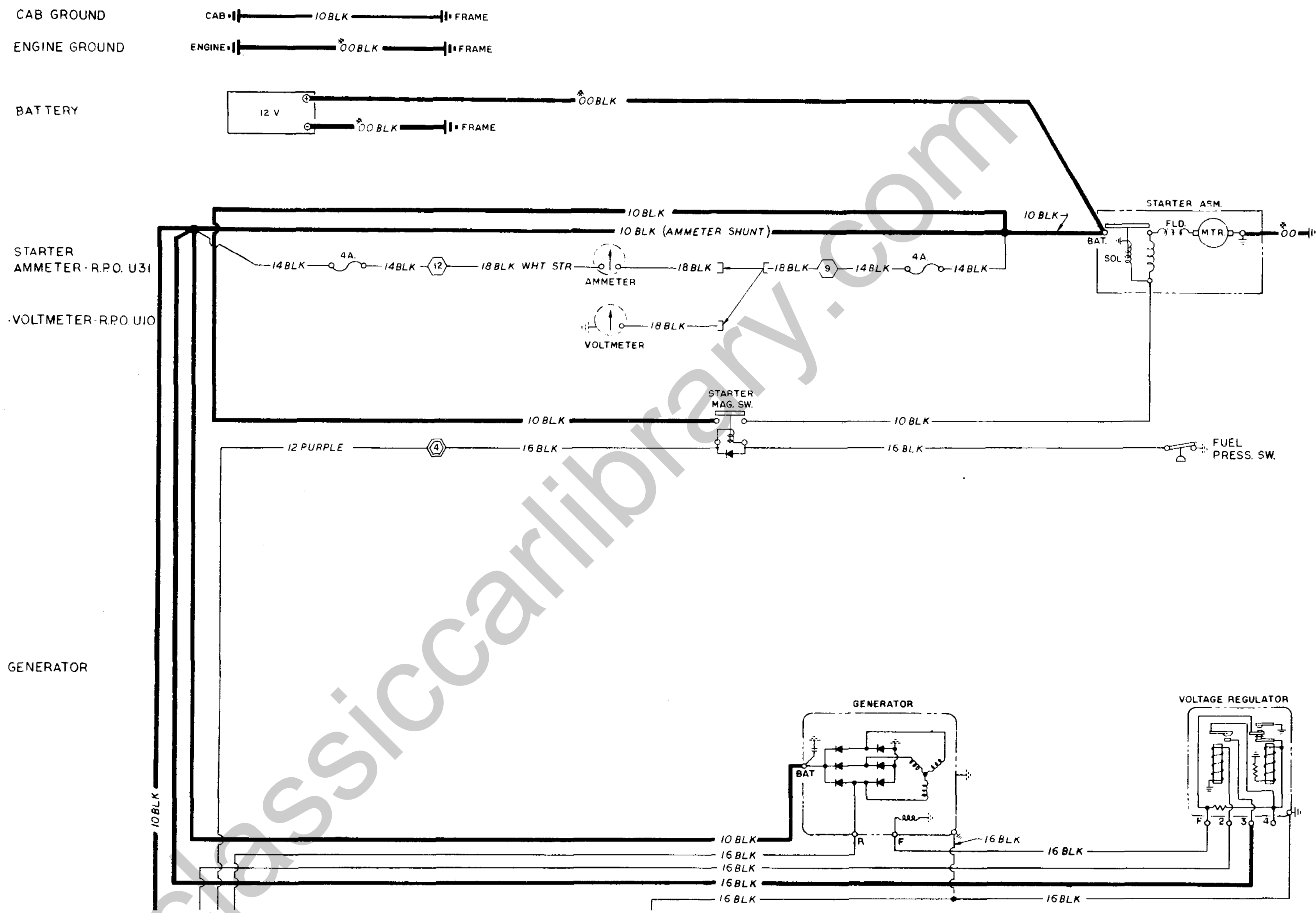
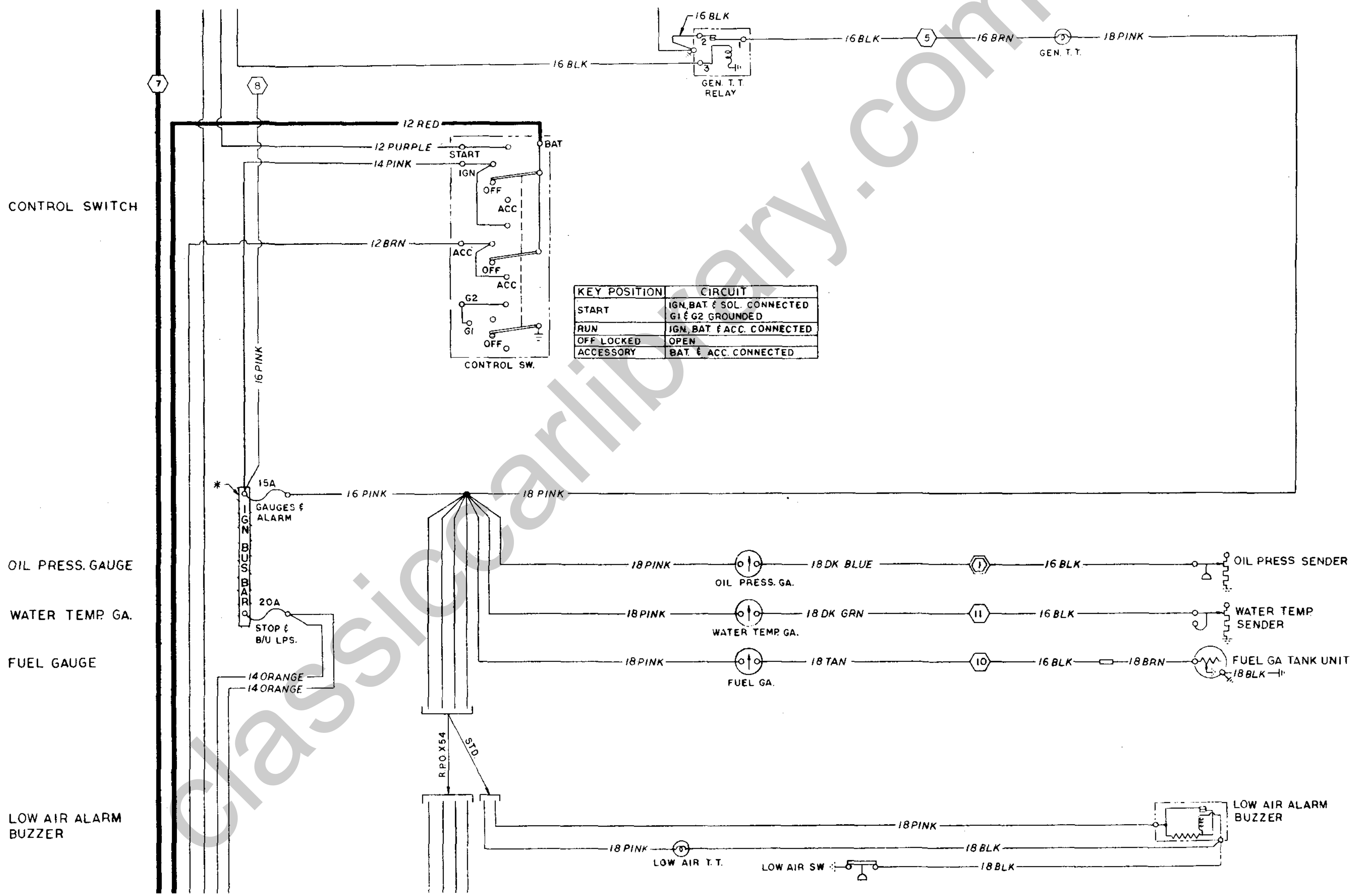


Figure 44—Cab, Engine, and Chassis Wiring—TV70
Sheet 1 of 6



KEY POSITION	CIRCUIT
START	IGN, BAT. & SOL. CONNECTED G1 & G2 GROUNDED
RUN	IGN, BAT. & ACC. CONNECTED
OFF LOCKED	OPEN
ACCESSORY	BAT. & ACC. CONNECTED

Figure 44—Cab, Engine, and Chassis Wiring—TV70
Sheet 2 of 6

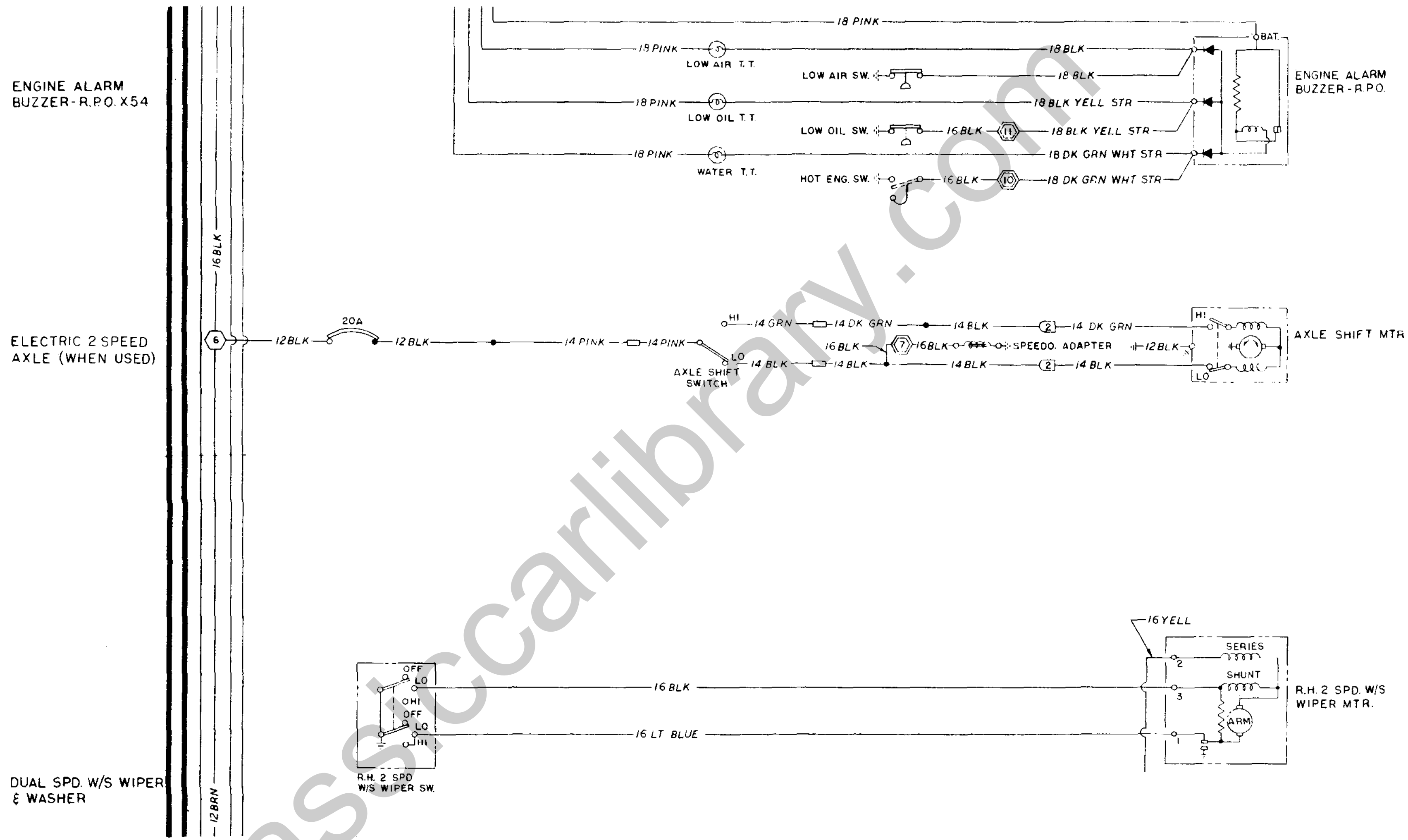


Figure 44—Cab, Engine, and Chassis Wiring—TV70

Sheet 3 of 6

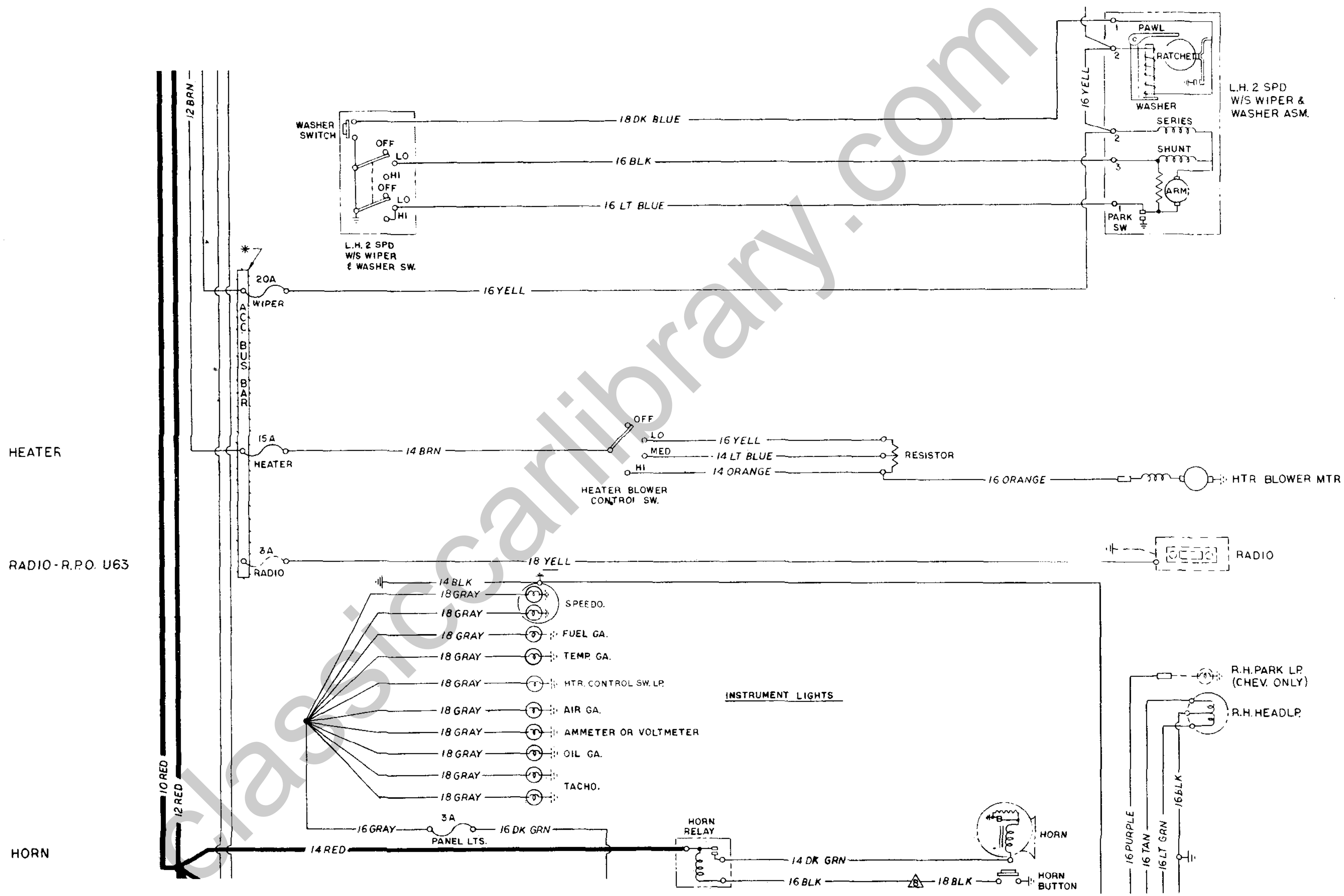


Figure 44—Cab, Engine, and Chassis Wiring—TV70
Sheet 4 of 6

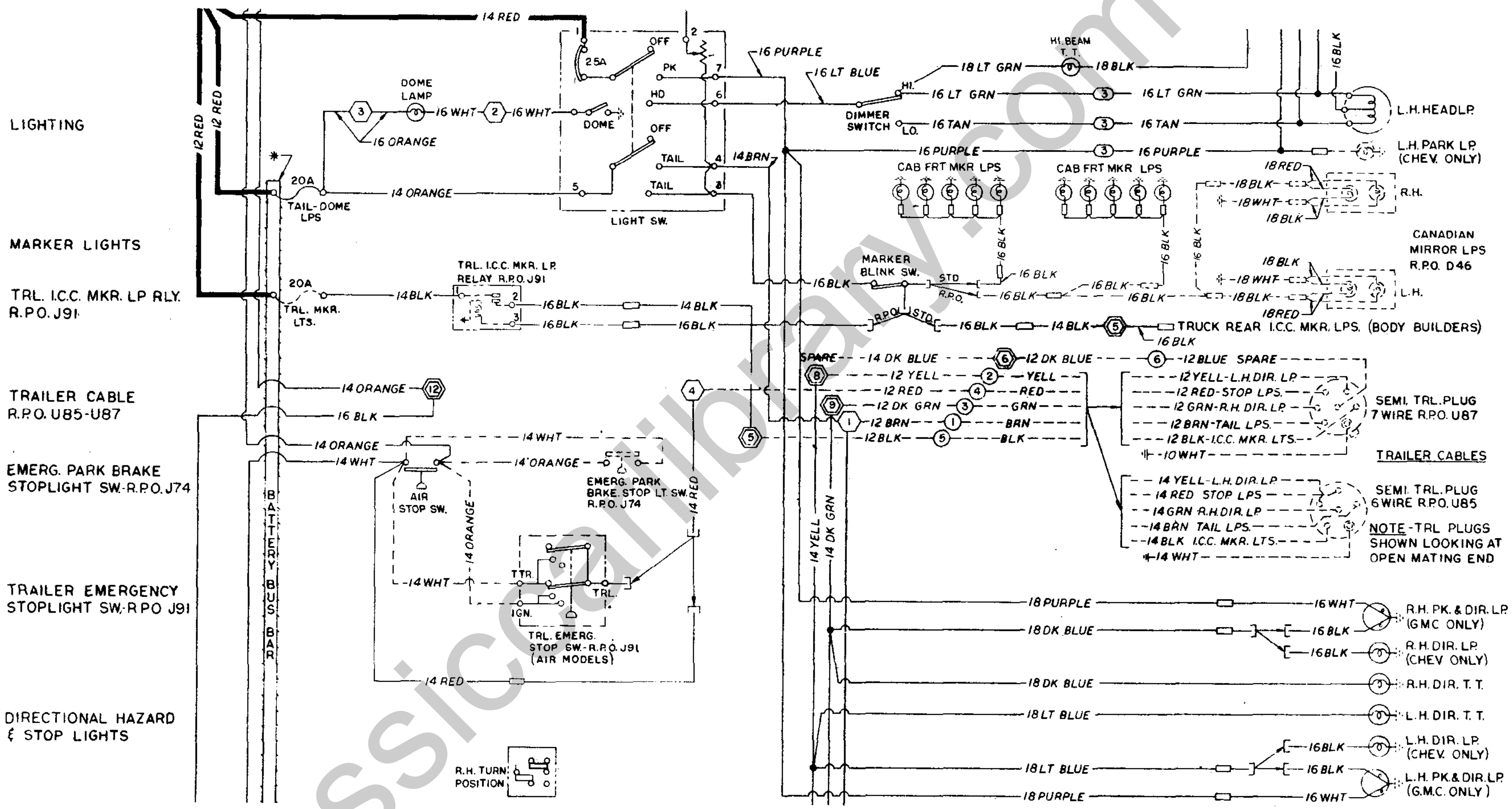
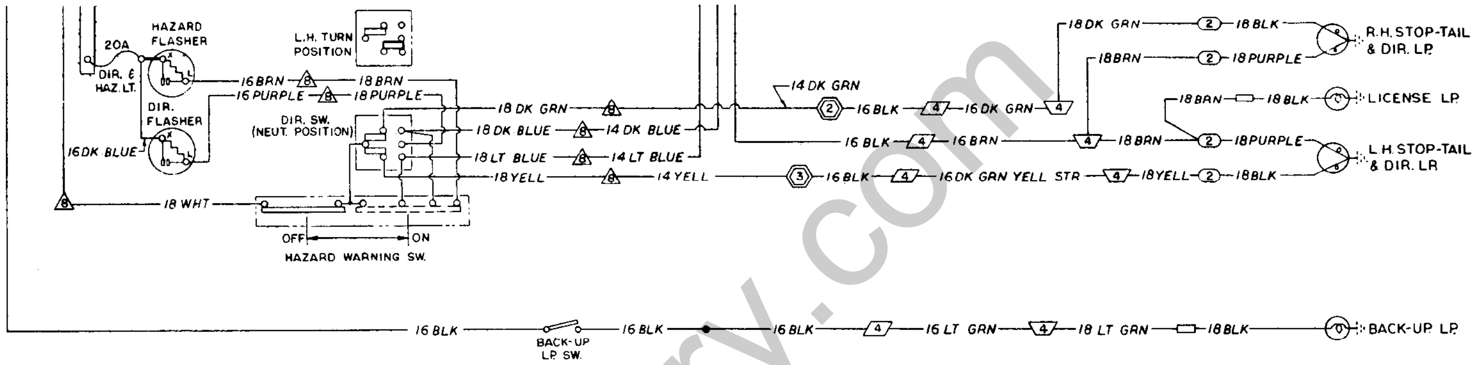


Figure 44—Cab, Engine, and Chassis Wiring—TV70
Sheet 5 of 6



CIRCUIT IDENTIFICATION

LEGEND

SYMBOL	JUNCTION	FUNCTION	LOCATION
⬡	12 POST JCT. BLOCK (*1 THRU *12) L.H.	INSTR. PANEL HARN. TO ENG. HARN. DOME LP. WIRE ASM. & TRL. WRG. HARN.	CAB JCT BELOW FLOOR AT L.H. FRT. STEP RISER
⬡	12 POST JCT. BLOCK (*1 THRU *12) R.H. - WIRES WITH RED SLEEVE		
○	6 POST JCT. BLOCK (*1 THRU *6)	TRL. WRG. HARN. TO TRL. CABLE ASM.	UNDER CAB AT CAB REAR
△8	8 WAY MULTIPLE CONNECTOR	DIRECT SW. ASM. TO INSTR. PNL. HARN.	UNDER INSTR. PANEL AT STEERING COLUMN
③	3 WAY MULTIPLE CONNECTOR	INSTR. PANEL HARN. TO HDLP. & PARK LP. HARN.	BELOW FLOOR AT L.H. HDLP. ASM.
▱4	4 WAY MULTIPLE CONNECTOR	ENG. HARN. TO STOP-TAIL LP. FRT. EXT. HARN.	L.H. FRAME RAIL AT BACK OF CAB
▽4	4 WAY MULTIPLE CONNECTOR	STOP-TAIL LP. FRT. EXT. HARN. TO REAR STOP-TAIL LP. HARN.	L.H. FRAME RAIL AT REAR AXLE
②	2 WAY MULTIPLE CONNECTOR	REAR STOP-TAIL LP. HARN. TO STOP-TAIL LP. ASM.	AT STOP-TAIL LP. ASM.
[2]	2 WAY MULTIPLE CONNECTOR	ENG HARN TO AXLE SHIFT MTR CABLE	L.H. FRAME AT BACK OF CAB
*	BUS BAR PART OF FUSE BLOCK - FUSE BLOCK PART OF INSTR. PANEL HARN. ASM.		
	FUSE		FUSE BLOCK-INSIDE CAB L.H. SIDE COWL PANEL
BAT. AUX.	CIRCUIT BREAKER		CAB. JCT. BELOW FLOOR AT L.H. FRT. STEP RISER
▭	SINGLE LINE CONNECTOR		RELATED CIRCUITS
o	TERMINAL OR CONNECTOR TERMINATION		RELATED CIRCUITS
•	SPLICE		RELATED CIRCUITS
	LINE FUSE		RELATED CIRCUITS

---- BROKEN LINES & SPECIFIED R.P.O. DENOTE WRG. & PARTS OTHER THAN STD. & NOT IN STD. WRG. HARN. ASM.

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Figure 44—Cab, Engine, and Chassis Wiring—TV70

Sheet 6 of 6

SECTION 13

RADIATOR AND SURGE TANK

All radiator core assemblies consist of three components: Upper tank, center core section, and the lower tank. All steel tilt cab models are equipped with a separate surge tank mounted above the level of the radiator core. The upper tank on both 71 Series Detroit Diesel and Cummins Engines has a surge compartment which is designed as an integral part of the tank, thus eliminating the need of a separate unit.

Pressure cooling is used on all vehicles. Coolant in a pressurized system does not boil until temperature exceeds the normal boiling point of water. Also, in a pressurized cooling system, coolant is not lost by evaporation.

Cooling system pressure relief valve is integral with filler cap on all models. Pressure control is arranged so that excessive pressure is released through system overflow line which directs coolant out below the engine.

NOTE: For information pertaining to engine thermostats and coolant capacities for all models, refer to "Specifications" listed in ENGINE COOLING SYSTEM (SEC. 6K) of this manual.

RADIATOR MOUNTING

Radiator mounting maintenance is of extreme importance and is too frequently overlooked. A check should be made to assure that no looseness exists that could permit excessive vibration and shock loads. Rubber cushions and rebound springs are subject to deterioration, weakening, and breakage, and should be replaced if in doubtful condition.

The radiator on all conventional cab models, is trunnion-mounted with a stabilizer rod provided at each side to adjust and maintain position of radiator as shown in figure 3.

The lower radiator support on 70 Series steel tilt cab models is bolted to a mounting bracket as shown in figure 4. Top of radiator is mounted on each side to the control island frame.

Radiator in Alum. Tilt vehicles is trunnion-mounted with a stabilizer rod provided at each side to adjust and maintain the position of the radiator. Figure 3 illustrates typical radiator installation in Alum. Tilt vehicles.

RADIATOR CORE REPLACEMENT

HM, JM 80

Removal (Figs. 1 and 2)

1. Remove radiator shell and radiator core assembly as described in SHEET METAL AND FIBERGLASS (SEC. 11) of this manual.
2. Remove bolts retaining fan shroud to radiator support, then remove fan shroud.
3. Remove attaching parts retaining radiator core to radiator shell. Then carefully remove radiator from radiator shell.
4. Inspect radiator seals (attached to radiator shell) for cracks or tears. If condition of seal is deteriorated, seals should be replaced.

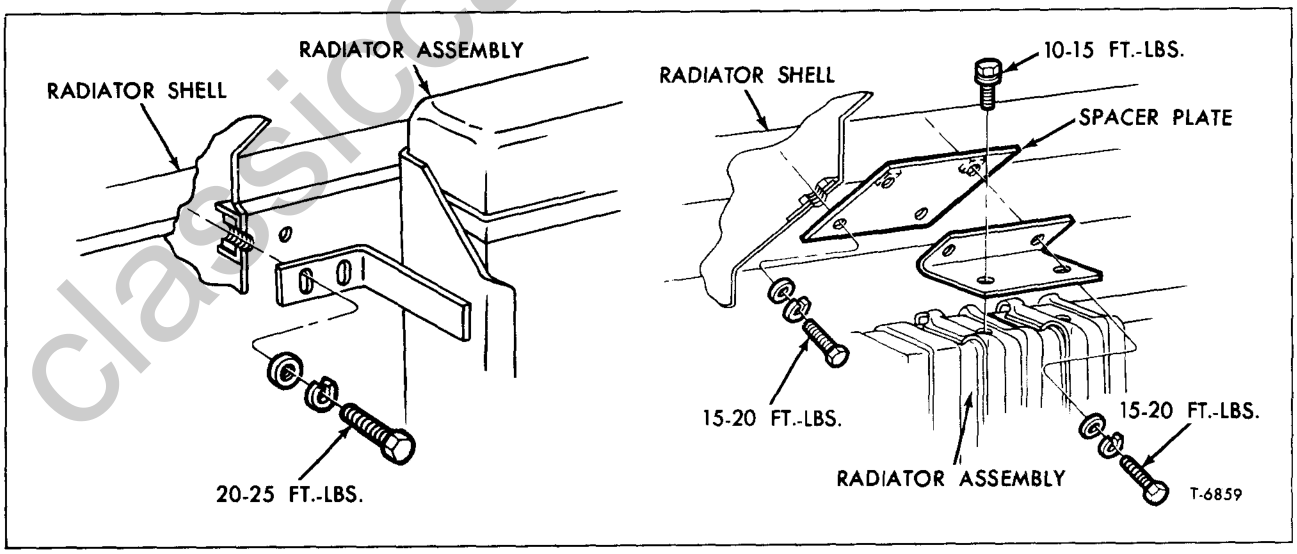


Figure 1—Radiator Upper Mounting (HM, JM80)

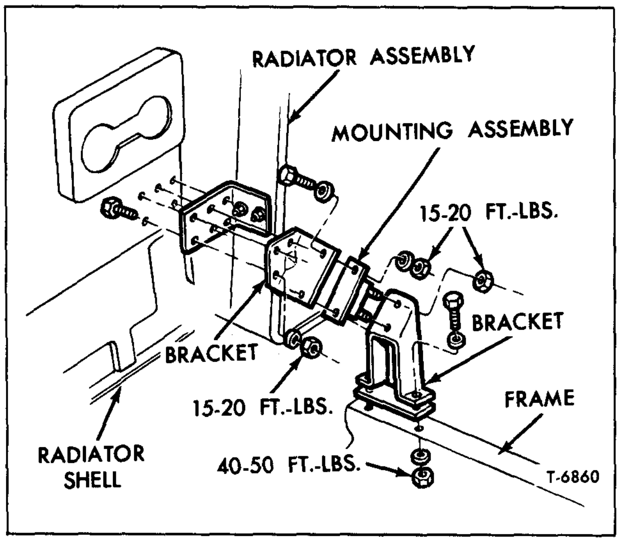


Figure 2—Radiator Lower Mounting (HM, JM80)

Installation (Figs. 1 and 2)

1. Carefully place radiator core in position on radiator shell. Tighten all attaching to proper torque as indicated in figures 1 and 2.

2. Position radiator shroud on radiator core support and tighten attaching bolts securely.

3. Install radiator shell and radiator core assembly as described in SHEET METAL AND FIBERGLASS (SEC. 11) of this manual.

4. Before starting vehicle when checking for leaks in cooling system be sure fan shroud clears the engine fan. If interference exists it may be necessary to readjust front end sheet metal and add shims at radiator shell mounting points. In addition check for deteriorated engine mounts.

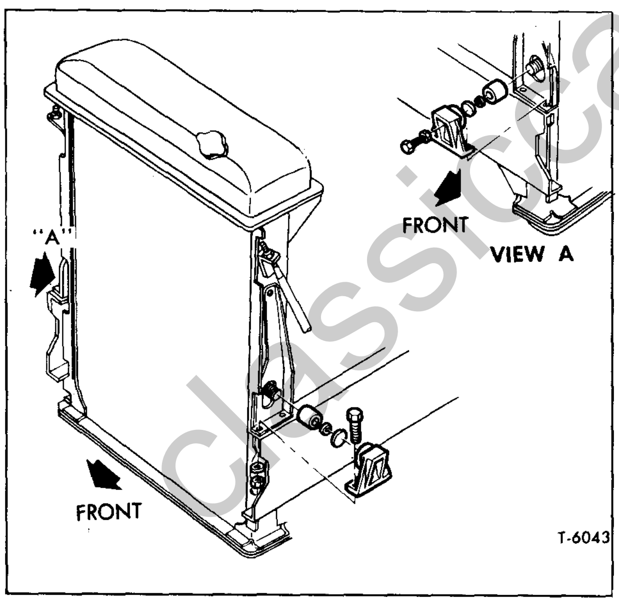


Figure3—Radiator Installation (Alum. Tilt and all Conv. Cab Models, except HM, JM80)

CONVENTIONAL CAB MODELS, EXCEPT HM, JM 80

Removal (Fig. 3)

1. Gain access to radiator core as follows:

a. Fiberglass Hood - Tilt the hood assembly forward.

b. Sheet Metal Hood - Remove the hood assembly as described in SHEET METAL AND FIBERGLASS (SEC. 11) of this manual.

2. Drain radiator. Disconnect lines and drain oil cooler. Disconnect all coolant hoses and oil lines from radiator core assembly.

3. If vehicle is equipped with air conditioning or power steering, remove cooling coils from radiator. In addition, remove power steering reservoir and receiver-dehydrator if attached to radiator.

4. Remove fan shroud attaching bolts, then lay shroud back over fan blade.

5. Remove upper nut, washer, and insulator from each radiator stabilizer rod (see fig. 4).

NOTE: Do not move lower nut or adjusting nut on either stabilizer rod.

6. Attach a lifting sling or chain to each radiator upper mounting bracket (5, fig. 4).

7. With a chainfall supporting radiator (using sling or chain) remove attaching parts retaining trunnion mounting brackets to frame. Raise core slightly and remove trunnion type mounting brackets. Carefully lift radiator assembly from vehicle.

Installation (Fig. 3)

1. Using a chainfall and sling (attached to radiator upper mounting brackets) carefully lift radiator assembly into position in vehicle.

2. Install trunnion brackets with rubber insulator, washer, and spacer to radiator core trunnions. Attach each bracket to frame with two bolts, washers, and nuts. Tighten nuts to 40-50 foot-pounds torque.

3. If necessary to center radiator, refer to "Radiator to Frame Clearance Adjustment" covered later in this section.

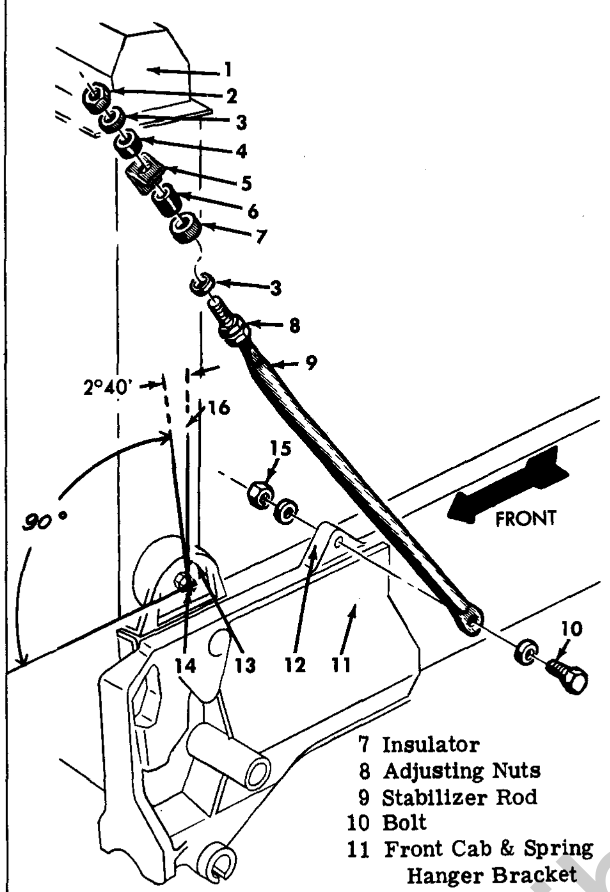
4. Install upper insulator, washer, and nut on each radiator stabilizer rod. Tighten upper nut on each rod securely. Proper angularity of radiator is shown in figure 4.

5. Install fan shroud.

6. Install air conditioning and power steering cooling coils, power steering reservoir, and receiver-dehydrator (if removed).

7. Connect all coolant hoses and oil lines to radiator core assembly.

8. Be sure hoses, lines, brackets, or fan shroud will not interfere with operation of fan.



7 Insulator
8 Adjusting Nuts
9 Stabilizer Rod
10 Bolt
11 Front Cab & Spring Hanger Bracket
12 Stabilizer Lower Mount Bracket
13 Trunnion Bracket
14 Radiator Adjusting Bolt
15 Nut
16 Side Frame
T-6214-1

1 Upper Tank
2 Nut
3 Washer
4 Insulator
5 Upper Mounting Bracket
6 Spacer

Figure 4—Stabilizer Rod and Components

9. Add coolant to radiator, start engine and allow it to warm up. Inspect system for leaks. Recheck radiator coolant level and add coolant if necessary.

10. On models equipped with a sheet metal hood, install the hood assembly as described in SHEET METAL AND FIBERGLASS (SEC. 11) of this manual.

SERIES 70-80 STEEL TILT CABS

Removal (Refer to Fig. 5)

1. Drain radiator.
2. Disconnect throttle linkage at linkage bracket on radiator support.
3. Remove electrical components from radiator support assembly.
4. Disconnect upper and lower coolant hoses from radiator.
5. If vehicle is equipped with air conditioning or power steering cooling coils, remove coils if necessary. Disconnect oil cooler lines (if equipped). In addition, remove power steering reservoir and receiver-dehydrator if attached to radiator.
6. Remove nuts, washers, and spring from lower mount.
7. Remove upper mounting bolts and rubber bushings.
8. To remove radiator and support assembly, tilt assembly forward and lift assembly out of vehicle.
9. To remove radiator core assembly from support assembly, remove cap screws from fan shroud and remove fan shroud. Remove cap screws attaching radiator core assembly to support assembly and remove core assembly.

Installation (Refer to Fig. 3)

1. Position radiator core assembly in support assembly and secure with cap screws.
2. Install shroud and retain with cap screws.
3. Carefully place radiator and support as-

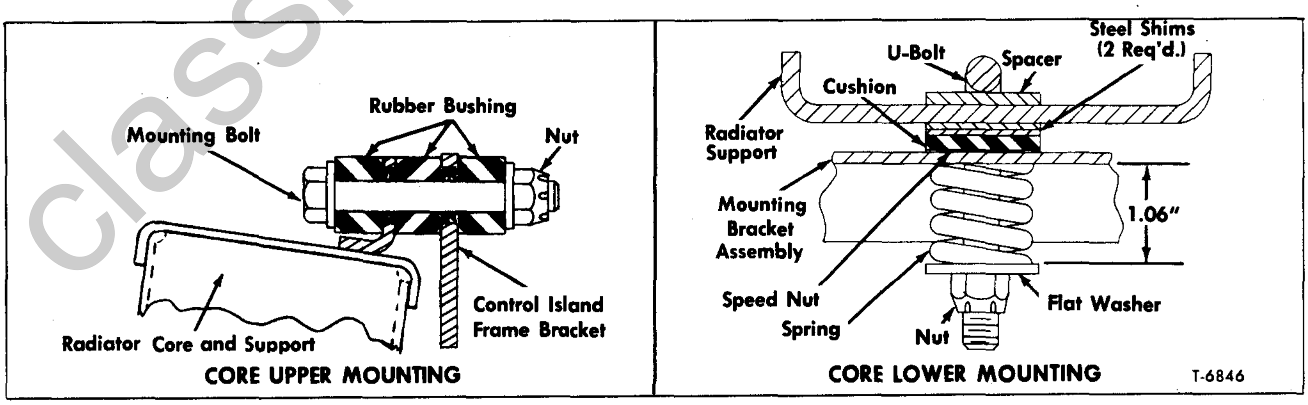


Figure 5—Radiator Upper and Lower Mounting (Series 70-80 Steel Tilt Cab) (Typical)

sembly in vehicle. Be sure components of lower mount are properly positioned.

4. Assemble radiator upper mounts and complete assembly of lower mounts.

5. Connect upper and lower coolant hoses to radiator. Also, connect oil cooler lines (if equipped).

6. Install air conditioning or power steering cooling coils, and power steering reservoir and receiver-dehydrator (if removed).

7. Install electrical components on radiator and connect throttle linkage to radiator support.

8. Fill cooling system and inspect system for leaks.

ALUMINUM TILT CABS

Removal (Refer to Fig. 3)

1. Drain radiator.

2. Tilt cab to fully tilted position as described in "ALUMINUM TILT CABS" (SEC. 1D) of this manual.

3. Disconnect all hoses from radiator, and remove coolant level indicator wire from radiator tank probe unit if so equipped.

4. If vehicle is equipped with air conditioning or power steering, remove cooling coils from radiator. In addition, remove power steering reservoir and receiver-dehydrator if attached to radiator.

NOTE: Move the condenser and receiver-dehydrator as a unit, away from radiator as far as possible and tie in that position to prevent interference with radiator during removal. This method avoids the necessity of disconnecting air conditioning lines, and evacuating the system upon assembly.

5. Remove upper nut, washer and insulator from each radiator stabilizer rod (see fig. 4).

NOTE: Do not move lower nut or adjusting nut on either stabilizer rod.

6. Attach a lifting sling or chain to each radiator upper mounting bracket (5, fig. 4).

7. Remove any other tubes, brackets or lines that would interfere with vertical removal of radiator.

8. With a chainfall supporting radiator (using sling or chain) remove attaching parts retaining trunnion mounting brackets to frame. Raise core slightly and remove trunnion type mounting bracket.

NOTE: Radiator may not balance in an exact perpendicular manner with the lift hooks installed in upper mounting brackets, and it may be necessary to guide radiator past bottom of fan by pressing lower part of radiator forward.

9. Carefully raise and remove radiator with attached chainfall.

Installation (Refer to Fig. 3)

1. Using a chainfall and sling (attached to radiator upper mounting brackets) carefully lift radiator assembly into position in vehicle.

2. Install each trunnion bracket with rubber insulator, washer, and spacer to radiator core trunnions. Attach each bracket to frame with two bolts, washers, and nuts. Tighten nuts to 40-50 foot-pounds torque.

3. If necessary to center radiator, refer to "Radiator to Frame Clearance Adjustment" covered later in this section.

4. Install upper insulator, washer and nut on each radiator stabilizer rod. Tighten upper nut on each rod securely. Proper angularity of radiator is shown in figure 4.

5. Assemble all hoses to radiator fittings, then tighten clamps firmly. Install coolant low level indicator wire terminal, to probe on upper tank if so equipped.

6. Carefully install air conditioning and power steering cooling coils, power steering reservoir, and receiver-dehydrator (if removed).

7. Connect or install all other items that were removed or disconnected during radiator removal.

8. Be sure hoses, lines, brackets, or fan shroud will not interfere with operation of fan.

9. Add coolant to radiator, start engine and allow it to warm up. Inspect system for leaks. Recheck radiator coolant level and add coolant if necessary.

RADIATOR REPAIR

The radiators on 71 Series Detroit Diesel and Cummins Engines are designed so that they may be disassembled for repair and cleaning if necessary.

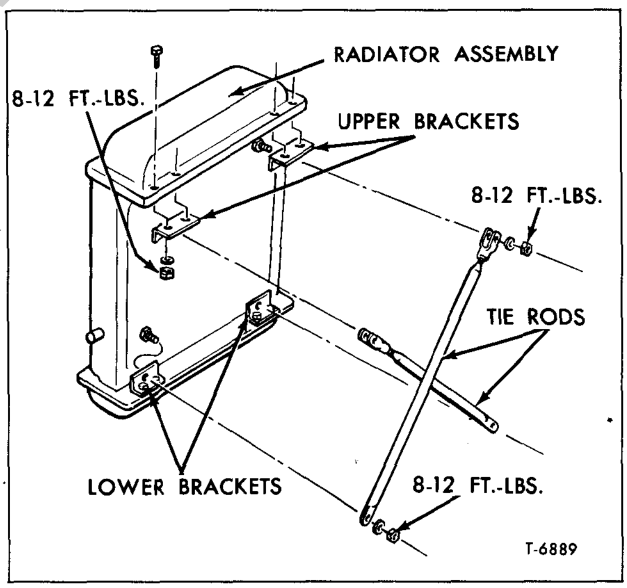


Figure 6 —Radiator Tie Rod Installation

DISASSEMBLY

1. To remove radiator fan shroud, remove retaining bolts and nuts at sides of radiator, then lift sections of shroud from core.

NOTE: Referring to figure 4, on all radiators equipped with tie rods as shown, remove tie rod upper and lower mounting brackets (with tie rods attached to brackets). If tie rod assembly is damaged, replace components as necessary.

IMPORTANT: Early models used separate upper and lower brackets which held the tie rods to radiator. On later models these brackets are part of the radiator.

2. Remove bolts and nuts at upper tank flanges, which retain the tank to core.

3. Separate the tank from core, by inserting screwdriver between flanges of tank and core. Carefully pry the two components apart, while alternating the prying point around the tank flanges. Remove gasket from tank and discard.

4. Remove the lower tank by following the procedure described in Step 3 previously.

5. Separate reinforcing components from radiator core flange if stuck together. Remove radiator side frames by pulling or prying apart.

CLEANING INSPECTION AND REPAIR

All radiator internal ports, and openings should be clean and free of any rust build-up, or scale deposits. Inspect all chambers, and core tubes for this condition, and if deposits are noted, scrape them away using care not to damage the thin portion of core. Pass a piece of wire or flat stock steel of suitable size through the tubes of radiator core, until all blockage of tubes is eliminated. If damage to tubes has occurred either from accident or erosion, core should be repaired at a reliable repair shop, or by a repairman competent in the trade.

All mating surfaces of tank and flanges, must be clean and free of dirt or foreign matter if gaskets can be expected to seal properly. Inspect all brackets and reinforcing parts for cracks and repair as needed.

ASSEMBLY

1. Place the lower tank and reinforcing components on radiator core lower flange, with gasket sandwiched between tank and core flange.

2. Loosely install several bolts and nuts through holes in tank flanges at each side of tank; leave bolts out of ends of tank so sufficient room will remain to permit installation of side frames later.

3. Position tank gasket on upper core flange, then place upper tank on gasket, and assemble the reinforcing pieces to the underside of flange. Loosely install several bolts and nuts at each side of tank through flange holes to keep the assembly intact, while completing the remaining operations. Leave space at ends for installation of side frames.

4. Position the side frames to radiator flanges at both ends and over core ends. Inspect tank flanges for correct gasket installation. Install all remaining bolts and nuts in tank flange bolt holes of upper and lower tanks.

NOTE: Referring to figure 6, on all radiators equipped with tie rods, install tie rod and brackets to upper and lower tank flanges as shown. Adjust clevis on the end of each rod as necessary to obtain proper tie rod length.

5. Inspect radiator for overall correct installation of components. Tighten all tank gasket bolt nuts, alternately and evenly a little at a time, while alternating from side to side of tank flange. Final bolt nut torque should be 15 foot-pounds.

IMPORTANT: If a pressure test of the repaired radiator is desired, test pressure of under 15 lbs. per-square-inch should be used.

SIGHT GLASS

A sight glass is incorporated in the radiator upper tank on most models in this manual, which allows Service Technician to readily check coolant level. Sight glass is retained to tank cavity by means of screw-type threads which are molded on sight glass. Unit is sealed to tank through use of an O-ring type seal, and is easily removed by twisting glass in a *counterclockwise* direction.

LOW COOLANT PROBE (IF USED) (TANK UNIT)

Low coolant probe is a one-piece unit and is secured to tank by threading the probe clockwise into tank opening. Probe has 1/8-inch pipe threads and is made of a material which is self-sealing.

Unit should be tightened to tank at 50-inch-pounds torque. Recommended torque of the wire terminal nut is 18 inch-pounds *maximum*.

For troubleshooting procedure of the low coolant electrical system, refer to CHASSIS ELECTRICAL AND INSTRUMENTS (SEC. 12) of this manual.

RADIATOR TO FRAME CLEARANCE ADJUSTMENT

NOTE: The following procedure applies to all models equipped with trunnion type radiator mountings as shown in figure 4.

If it should become necessary to center the

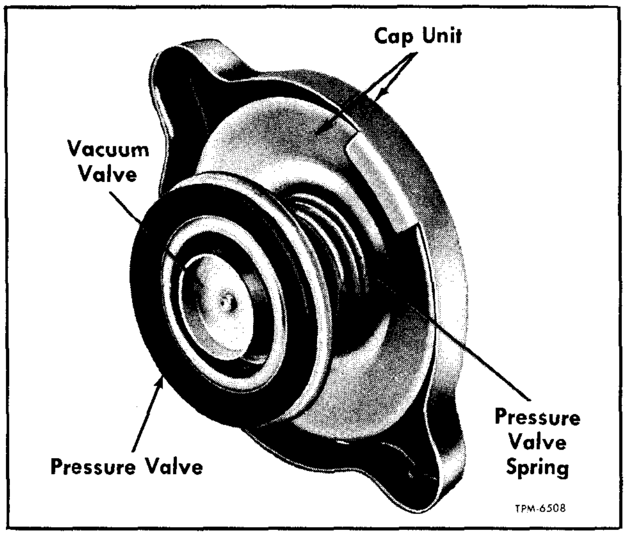


Figure 7 —Combination Pressure Relief Valve and Filler Cap

radiator to the frame side rails, the radiator side adjustment can be made as follows:

Loosen both adjusting bolt lock nuts (14, fig. 4) at each side of radiator trunnion mounting brackets. Back bolt out of mount in the direction of the desired movement. Thread bolt inward on opposite side of radiator until radiator is centered as desired. Make certain that both adjusting bolts are tight against radiator trunnion, and that no slack exists. Tighten adjusting bolt lock nuts firmly.

RADIATOR SURGE TANK

A separate radiator surge tank is used on some models covered by this manual. The surge tank serves as a coolant reservoir for the radiator core which is mounted low to front of engine. Hoses and pipes connect tank to radiator and water pump. Supply tank incorporates the cooling system filler cap which is accessible on steel tilt cabs from inside cab through small door at top of seat riser. To gain access to supply tank itself, tilt cab forward.

At regular intervals connecting hoses between surge tank and radiator should be checked for leaks. Keep all hose clamps and mounting bolts tightened securely.

PRESSURE RELIEF VALVE AND FILLER CAP

Pressure relief valve assembly, integral with radiator filler cap, incorporates a pressure valve and a vacuum valve (fig. 7). When pressure in system reaches valve setting (see "Specifications" at end of this section), pressure valve opens and vapor is allowed to escape. As liquid in system cools it contracts; this allows pressure valve to close and also creates a partial vacuum in system. Atmospheric pressure acting through overflow tube unseats vacuum valve and allows air to enter system. The overflow pipe connects to valve outside the valve seal; thus no liquid or air can escape from the system when both valves are in the closed position.

Radiator filler cap is constructed with a spring-loaded rubber seal which is pressed firmly against surface of filler neck seat when cap is installed. Rubber seal must be in good condition and top of radiator filler neck must be clean and smooth in order to form an air-tight seal. Seal of filler cap and operation of pressure relief valve can be checked using a conventional cooling system testing kit.

NOTE: When engine is at normal operating temperature or above, the internal pressure built up in the cooling system will blow out scalding fluid and vapors if the radiator cap is suddenly removed. To prevent loss of coolant and to avoid the danger of being burned, the coolant level should be checked or coolant added only when the engine is cool. If the cap must be removed when engine is hot, place a cloth over the cap and rotate the cap slowly counterclockwise to first stop and allow pressure to escape completely. Then turn cap again slowly counterclockwise to remove.

NOTE: A special testing kit for radiator filler caps can be obtained locally. Instructions supplied with kit should be followed.

ENGINE COOLANT

COOLANT RECOMMENDATIONS

The year-around engine coolant used to fill the cooling system at the factory is a high quality solution that meets General Motors Specification 1899-M. This factory-fill coolant solution is formulated to withstand two full calendar years of normal operation without draining or adding inhibitors, provided the same concentration of coolant is added if the system needs additional fluid between drain periods. The original factory fill coolant provides freezing protection to -20°F.

Every two years, the cooling system should be serviced as described in ENGINE COOLING SYSTEM (SEC. 6K) of this manual. A thorough description of inspection, draining, and cleaning of the cooling system is given.

IMPORTANT: Alcohol, methanol base coolants, or plain water are not recommended. Only a sufficient amount of Ethylene Glycol base coolant meeting GM Specification 1899-M should be used. DO NOT use glycol ether (methoxy propanal type) base permanent type anti-freeze coolants in DH

478 diesel engine as damage to cylinder head gasket seals will occur.

COOLANT TESTING

Always test solution before adding water or anti-freeze. Engine should be warmed up to operating temperature. Fill and empty tester several times to warm tester before using. Keep tester clean inside and out.

Some testers will indicate correct freezing point only when test is made at a specific temperature. Other testers are provided with thermometers and tables and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperatures of solution may cause an error as large as 30°F. Read and be guided by instructions furnished by tester manufacturer.

In the event coolant freezes solid in extreme cold weather, place vehicle in warm building or improvise some means of thawing coolant before starting engine. Under no circumstances should engine be operated when coolant is frozen solid. After thawing, refill system with a higher concentration of anti-freeze solution and start engine. Inspect entire system for leakage and then test coolant with hydrometer to determine if adequate anti-freeze protection is provided.

COOLANT PRECAUTIONS

1. Overheating is not always caused by a defective cooling system; incorrect ignition timing, dragging brakes, under-inflated tires, and improper use of transmission gears can cause overheating.
2. Keep water pump and fan drive belts at proper tension. Refer to ENGINE COOLING SYSTEM (SEC. 6K) of this manual.
3. Do not over-fill cooling system. Expansion of coolant when hot will cause loss of coolant through overflow tube.
4. Do not remove radiator filler cap when engine is hot. Wait until system cools off.
5. Do not pour cold water into cooling system when the engine is hot. Wait until system cools off.
6. If cooling system requires frequent refilling, check for leaks.
7. Keep all connections tight, and make sure gasket on radiator filler cap is in good condition.
8. When filling system with anti-freeze solution ALWAYS FOLLOW RECOMMENDATIONS of anti-freeze manufacturer.
9. Use only Ethylene Glycol base coolant meeting GM Specification 1899-M.
10. Drain and flush cooling system every other year, preferably at start or end of winter operation.

RADIATOR SHUTTERS AND CONTROLS

Radiator shutters (fig. 6) used on some models covered by this manual are operated by temperature controlled air pressure. Shutters are actuated by an air cylinder which is mechanically linked to shutter control.

Shutters are either fully open or completely closed, since shutter action depends upon engine temperature, as sensed by the shutterstat.

Shutterstat is installed in engine water manifold on all models except TV 70. Shutterstat on TV 70 is mounted on a tee located in the radiator return hose. Until engine temperature rises to a predetermined setting, shutters remain closed providing air pressure in system is sufficiently high. With engine cold and air pressure depleted, shutters are open until such time as air pressure builds up to approximately 40 psi. When shutterstat operating temperature is attained, thermostatic action shuts off air supply to air cylinder, and simultaneously exhausts air pressure from cylinder. Shutter spring action then opens the shutters.

SHUTTERS

SHUTTER MAINTENANCE

Maintain radiator shutter unit in free working condition by cleaning vane bearings thoroughly. Blow with high pressure air hose to ensure removal of all dirt. If shutter is removed, use suitable solvent or penetrating oil applied with brush or spray gun.

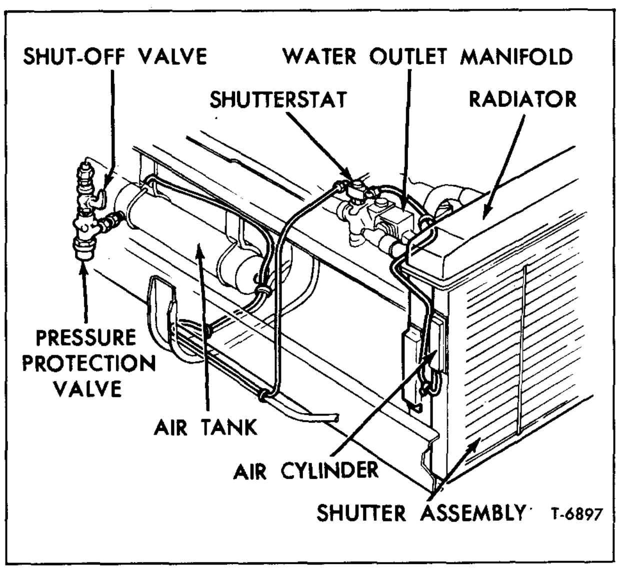


Figure 8 —Typical Radiator Shutter Installation

After shutter is worn in, lubricating oil may be applied to angle bearings every 20,000 miles. Use oil sparingly; frictional wear is very slight, and an excessive amount of lubricant may increase collection of dirt.

SHUTTER REMOVAL

1. Tilt cab to full tilted position (alum tilt).
2. Drain air in system, or close shut-off valve in supply line at the air tank. Disconnect air line fitting at bottom of air cylinder.
3. Remove screws at side mounting brackets which retain assembly to radiator frame.
4. Remove the shutter assembly by raising straight up from radiator. Maneuver unit as necessary to clear any obstructions.

DISASSEMBLY

1. Remove screw at base of air cylinder cover which retains cover to shutter. Pull cover outward at bottom and disengage hook from slot in top of shutter frame.
2. Remove C-washer or cotter pin from end of shutter control shaft. Remove air cylinder by disengaging hook from slot in shutter, then pull unit from control shaft.
3. At inside of shutter, disconnect the return springs at each side of frame. Remove springs from shutter assembly.

NOTE: Observe installation of anti-rattle wire so it may be properly re-installed.

4. Remove anti-rattle wire from both sides of shutter.
5. At front of shutter, remove all screws which fasten the shutter vane angle brackets to each side of shutter frame. Remove the screws which retain the center bar assembly to frame. Remove vane with end angles and center bar intact from shutter frame.
6. Remove C-washers from vane bearing pin and crank assembly at each side of control bar. Remove bar from vane pin ends.
7. Remove C-washers from ends of vane pins at both ends of vanes. Remove angles from ends of vane bearing pins.
8. If removal of vane pin bearings from angle brackets is desired, they may be driven out by using a drift tool of suitable size to press on outer circumference of bearing.
9. Remove screws from center bar assembly, then separate the two pieces with a screwdriver or sharp chisel.
10. Remove the Delrin vane bushings by prying them from center bar with small screwdriver.
11. Pry rubber seal from cavity of vane edge if replacement of seal is desired.

NOTE: Care should be exercised during removal of seal to prevent damage to lip of vane, and also to seal cavity as these parts may be readily damaged.

CLEANING, INSPECTION, AND REPAIR

Clean all components in a suitable solvent and dry with air pressure.

Inspect vanes, bearing channels, and frame for cracks at corners, bearing cavities, and at mounting points. Inspect vane bearing pins and crank pin assembly for worn condition. If excessive wear exists, part should be replaced since these parts are not serviceable. Check bearing and bushing inside diameters for wear. If undue wear is present, install new parts. Inspect rubber seals in vane edges for evidence of deterioration. If new rubber vane seals are to be installed, channel grooves must be clean and free of any obstruction to simplify installation of seal. An approved rubber lubricant may be used to aid in seating seal into vane channel.

ASSEMBLY

1. Assemble the center bar to all shutter vanes with the Delrin bushing halves properly placed in bar bushing depression. Assemble sections of center bar to center bearing pin with thick half of bar to front side of shutter.

NOTE: All vane crank pins must be on right side of shutter assembly, with vane seals facing toward radiator with shutter in open position.

2. Tighten all screws securely, then check vanes for freedom of movement.
3. Assemble bearing angles to ends of vanes and over vane bearing pins. Flange of angle must be facing outward from vanes so it will align with shutter frame.
4. Install C-washers in pin grooves at outer side of angles at vane pivots. Assemble control bar over vane crank pins, then install C-washers in pin grooves on both sides of control bar.
5. Position shutter vane assembly on inside of shutter frame, and align to frame bolt holes. Install retaining screws and tighten firmly. Install center bar mounting screws and tighten firmly.
6. Install anti-rattle wire at each side of pin angles as noted previously in removal. Connect control bar springs to spring anchor stud on control bar and shutter frame.
7. Engage air cylinder mounting bracket upper hook in slot in shutter frame, while positioning cylinder shaft eye with bushings over control bar stud. Insert C-washer in groove of control bar stud.
8. Insert hook of air cylinder cover in slot of shutter frame and over air cylinder. Align bolt holes at base of air cover, then install cap screw, and tighten firmly.

INSTALLATION

1. Place shutter assembly in place at radiator front. Align bolt holes with openings in radiator frame. Install cap screws and tighten securely.

2. Connect air line fitting firmly to air cylinder. Start and run engine until air pressure is built up, and normal operating temperature is obtained. Observe shutters for correct operation. Also check air line connections for leaks.

SHUTTERSTAT

ON-VEHICLE TEST

If it is suspected that the shutterstat is not functioning properly, test of shutterstat can be conducted as follows:

1. Remove pressure cap from radiator top tank and immerse thermometer in coolant. Thermometer must not contact radiator core or top tank.

2. Start engine and operate at 800-900 rpm to ensure good circulation of coolant.

3. Operate engine until shutter opening occurs. Allow shutters to open and close twice. Observe temperature at which shutters open for third time. If opening temperature is not approximately 188 to 192°F.,it may be necessary to replace shutterstat in order to obtain the desired shutter operation.

IMPORTANT: Do not loosen lock nut or rotate power element at base of shutterstat (refer to fig. 9). An O-ring seal is located beneath lock nut. Rotation of lock nut can cut O-ring seal, resulting in air being admitted to engine cooling system. This admission of air (at vehicle air pressure) could result in engine failure due to overheating.

OUT-OF-VEHICLE TEST

1. Connect air supply line to inlet port and air pressure gauge into air cylinder port of shutterstat.

2. Suspend shutterstat temperature sensing element in hot water up to mounting threads. Locate thermometer in the water near the shutterstat. Be certain neither thermometer or shutterstat contacts container.

3. Agitate water thoroughly while testing. Raise temperature of water gradually. Shutterstat should close and at same time exhaust the outlet pressure to gauge at 180°F. on all models, except TV 70 and DC, FC 90 with Cummins NT335 engine which should close at 190°F. Gauge should register "0" (zero). Temperature at which shutterstat closes for third time is the representative closing temperature of the shutterstat.

4. Closing of shutterstat is indicated by a pressure drop, while opening of shutterstat is indicated by a pressure rise as indicated on pressure gauge.

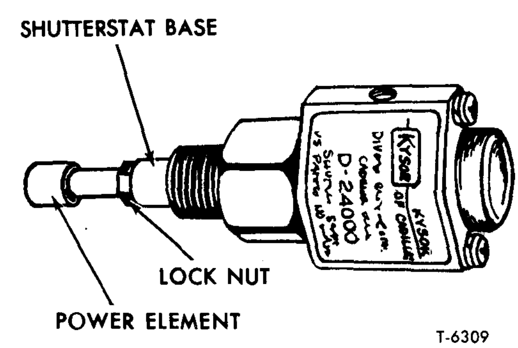


Figure 9—Shutterstat

5. If closing temperature of shutterstat is not approximately 180° or 190°F., as described above, shutterstat should be replaced if unit is out of range by 5 degrees.

REMOVAL

1. Lower coolant level by draining, to prevent loss of coolant.

2. Close shut-off cock in air supply line at the air tank.

3. Disconnect both air lines from shutterstat body, then cover the line openings to prevent contamination.

4. Unthread shutterstat from fitting in engine manifold, with wrench applied to hex portion of valve body.

INSTALLATION

1. Install sealer to threads of shutterstat, then thread unit into manifold and tighten firmly.

2. Connect air lines to shutterstat.

3. Open air pressure supply line shut-off valve. Replenish coolant in system.

4. Operate engine and inspect for water, and air leaks. Check system for correct operation.

AIR CYLINDER

ALL MODELS, EXCEPT TV 70

Testing and Repair

Shutter air cylinder is fastened to right side of shutter. Air cylinder may be tested for proper operation on vehicle by the following method. Disconnect shutterstat line to air cylinder, then hook air supply line directly to air cylinder and apply air pressure. Air cylinder should operate shutters at a minimum pressure of 40 pounds. If shutters open at correct air pressure trouble is in some other component of system. Repair of cylinder is limited to replacement of boot and Delrin eye bushing.

Removal

1. Shut off air supply to air cylinder by closing shut-off cock at pressure tank.
2. Disconnect air line fitting at lower end of air cylinder, at right side of shutter.
3. Remove cap screw at base of cylinder cover, then remove cover. Remove C-washer from end of control bar stud.
4. Remove air cylinder by pulling outward at base, while sliding upper eye off control bar stud.

Installation

Install air cylinder, by reversing the "Removal" procedure. Inspect system for leaks, and proper operation when completed.

TV 70 AIR CYLINDER

Removal

1. Close off air pressure by closing shut-off valve located on inside of right-hand frame rail.
2. Disconnect air supply line at upper end of air cylinder.
3. Remove cotter pin and two (2) cap screws retaining air cylinder to shutter assembly.
4. Remove air cylinder by pulling outward at base, while sliding upper eye off shutter control pin.

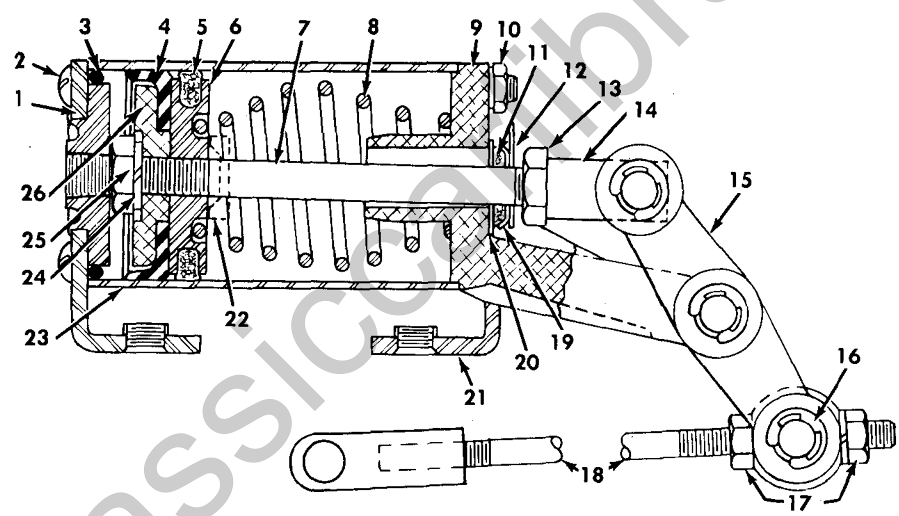
Disassembly

NOTE: Key numbers refer to figure 10.

1. Mark cylinder heads (1 and 9), cylinder (23), and mounting bracket (21) to ensure original position of parts when assembled later.
2. Unless control rod assembly (18) is to be replaced, do not reposition adjusting nuts (17) and, leave control rod attached to bell crank (15).
3. Remove nuts (10) from four bolts (2) which hold cylinder assembly together. Separate cylinder heads and pull piston assembly from cylinder (23).
4. Remove seal ring (3).
5. Remove nut (25) and washer (24) from piston rod (7), then remove piston follower (26), piston cup (4), and piston (6) from piston rod (7).
6. Remove piston felt (5) from piston.
7. Remove return spring (8) from piston rod.
8. Separate rod and pin assembly (14) from bell crank (15). Rotate bell crank, then remove piston rod and rod end assembly from cylinder head (9).
9. Remove retainer (12), dust cap (19), felt (11) and washer (20) from cylinder head.

Cleaning and Inspection

1. Wash all parts in a cleaning solvent and



1 Cylinder Head and Bracket
2 Bolt
3 Seal Ring
4 Piston Cup
5 Piston Felt
6 Piston
7 Piston Rod
8 Return Spring
9 Cylinder Head
10 Nut
11 Felt
12 Retainer
13 Jam Nut
14 Rod End and Pin Assembly
15 Bell Crank
16 "E" Retaining Ring
17 Adjusting Nut
18 Control Rod Assembly
19 Dust Cap
20 Washer
21 Mounting Bracket
22 Stop Collar
23 Cylinder
24 Washer
25 Jam Nut
26 Piston Follower

T-6845

Figure 10—Shutter Control Air Cylinder (TV70)

allow to dry.

2. Inspect all parts for wear. If excessive wear is evident, replace with new parts. Replace all seals in air cylinder.

Assembly

NOTE: Key numbers refer to figure 10.

1. Referring to figure 10 for proper positioning of parts, insert piston rod (7) through retainer (12), dust cap (19), felt (11), washer (20), and into cylinder head (9). With piston rod attached to rod end and pin assembly (14), secure bell crank (15) to rod end assembly with two "E" retaining rings (16).

2. Position the following parts on piston rod: Return spring (8), piston (6), with a new felt (5), piston cup (4), piston follower (26), washer (24), and nut (25). Tighten nut securely.

3. Carefully slip cylinder (23) over piston assembly, until cylinder makes contact with cylinder head (9).

4. With seal ring (3) in position, install cylinder head and bracket (1). Install through-bolts (2) and nuts (10). Tighten nuts securely.

5. Secure control rod assembly (18) to bell crank (15) utilizing adjusting nuts (17) and "E" retaining rings (16).

Installation

1. Install upper eye of air cylinder over shutter control pin. Secure with cotter pin. Install two cap screws retaining air cylinder to shutter assembly.

2. Connect air supply line at upper end of air cylinder.

3. Connect air supply by opening shut-off valve located on inside of right-hand frame rail.

4. Start vehicle, bring air pressure in system up to normal (approximately 105-120 psi). Check system for air leaks.

5. Adjust air cylinder linkage, if necessary.

NOTE: The actual adjustment is made by repositioning the shutter control rod assembly (18, fig. 10). Reposition two adjusting nuts (17) as required, with air applied until vanes of shutters are fully closed.

AIR PRESSURE PROTECTION VALVE

Air pressure protection valve (fig. 8) is installed in air supply line at air tank. Protection valve is designed to cut off air supply to shutter system, if pressure in system drops below 65 psi.

PROTECTION VALVE TEST

Drain air from air system.

Connect pressure gauge into supply side of valve between tank and valve. Allow air pressure to build up to 65 psi as indicated on gauge. This pressure should cause valve to open, and should result in delivery pressure of 50 psi. If it is desired to accurately check pressure of delivery line, a second gauge may be installed in delivery line and the exact pressure can then be determined. If pressures as determined from the above checks are not approximately correct, replace valve.

REMOVAL

1. Drain air from system.

2. Disconnect air line from shutters to protection valve. Disconnect remaining delivery line from valve.

3. Thread protection valve from air tank, then remove valve.

INSTALLATION

Reverse the "Removal" procedure, start engine and permit air in system to build up to at least 65 psi. Check shutter operation, and system for leaks.

SPECIFICATIONS

RADIATOR PRESSURE CAPS

Combination Filler Cap and Valve Type (Used on All Models)

Stamped	RC-12-9
Opening Pressure	9 Psi

COOLING SYSTEM NOTES AND PRECAUTIONS

1. Overheating is not always caused by a defective cooling system; incorrect ignition timing, dragging brakes, under-inflated tires, and improper use of transmission gears can cause overheating.
2. Keep water pump and fan drive belts at proper tension. Refer to ENGINE COOLING SYSTEM (SEC. 6K).
3. Do not over-fill cooling system. Expansion of coolant when hot will cause loss of coolant through overflow tube.
4. Do not remove radiator filler cap when engine is hot. Wait until system cools off.
5. Do not pour cold water into cooling system when the engine is hot. Wait until system cools off.
6. If cooling system requires frequent refilling, check for leaks.
7. Keep all connections tight, and make sure gasket on radiator filler cap is in good condition.
8. When filling system with anti-freeze solution ALWAYS FOLLOW RECOMMENDATIONS of anti-freeze manufacturer.
9. Use only Ethylene Glycol base coolant meeting GM Specification 1899-M.
10. Drain and flush cooling system every other year, preferably at the beginning or end of winter operation.

SPECIAL TOOLS

References are made to special tools in the various sections of this manual. These tools, or their equivalent, are necessary and are recommended to readily and efficiently accomplish certain service operations.

SECTION 1 - CAB AND BODY

Tool No.	Tool Name
J-2189	Glass Seal and Insert Installer
J-9316	Windshield Alignment Blocks (Tilt Cab)
J-9886	Door Inside Handle Clip Remover
AIR CONDITIONING	
J-5725-04	Gauge Set
J-5420	Valve Adapter
J-9459	Valve Adapter
J-5428 or J-5428-02	Vacuum Pump
J-8695-18	Hose-to-Drum Adapter
J-6084	Leak Detector
J-6272-01	Multi-Opener
J-6271	Fits-All Valve (1 Can Opener)
J-8393	Deluxe Portable A/C Service Station
J-22132-01	Schrader Valve Core Replacer
J-22974	Seal Installation Tool
*J-23573	Belt Tension Gauge
*J-23586	Belt Tension Gauge

SECTION 3C - FRONT SPRINGS

J-553	Adapter - Spring Pin or Bolt (Use w/J-2619)
*J-2619	Slide Hammer
*J-21058	Remover and Replacer (Plain Spring Eye Bushing)

SECTION 4A - REAR AXLE

J-3453	Pinion Yoke Holding Bar
J-8107	Puller

SECTION 4B - REAR SPRINGS

J-8118	Spring Pin Puller (Use w/J-2619)
*J-2619	Slide Hammer
*J-21058	Remover and Replacer (Plain Spring Eye Bushing)
J-8459	Remover and Replacer (Radius Leaf Eye Bushing)
J-6888	Valve Core Replacer
J-8424	Overtravel Lever Piston Compressor

SECTION 5A - HYDRAULIC BRAKES

J-4707	Adjusting Tool
J-22348	Brake Spring Tool

*Listed in more than one section.

SECTION 5B - AIR BRAKES

Tool No.	Tool Name
J-23527	Power Spring Compressing Fixture (Super "Fail Safe" Only)

SECTION 6A - GASOLINE ENGINES

J-21546	Air Hose Adapter
*J-21544	Valve Spring Compressor
*J-7879-01	Crankshaft Pulley Remover and Installer Set
*J-7879-10	Crankshaft Front Oil Seal Installer (Part of J-7879-01 Set)

SECTION 6C - 53 & 71 DIESEL ENGINE

J-9708	Feeler Gauge
J-7455	Valve Spring Compressor
J-4794-01	Crankshaft Pulley Remover
J-7773-1	Crankshaft Pulley Installer
J-1853	Injector Timing Gauge
J-1242	Injector Timing Gauge
J-3087-01	Cylinder Head Holding Plates
J-8932-01	Fuel Line Wrench
J-5895	Governor High Speed Retainer Wrench
J-3092-01	Push Rod Remover Set
J-9531-01	Diagnosis Kit

SECTION 6K - COOLING SYSTEM

J-4794-01	W/Pump Pulley Puller
J-1930	W/Pump Bearing Remover
J-4242	Special Wrench
J-22437	W/Pump Impeller Installer
J-22150	W/Pump Seal Remover
J-4646	Pliers

Tool No.	Tool Name
J-8501	W/Pump Seal Installer
J-7079-2	Installer Handle
*J-23573	Drive Belt Tension Gauge
*J-23586	Drive Belt Tension Gauge

SECTION 6M - GASOLINE ENGINE FUEL SYSTEM

J-8824	Carburetor Float Gauge
J-4395	Float Lever Bending Tool

SECTION 6M - 53 & 71 DIESEL FUEL INJECTION SYSTEM

J-1242	Injector Timing Tool
J-1853	Injector Timing Tool
J-8130	Injector Test Oil
J-5286-9	Injector Tube Reamer
J-8932-01	Fuel Line Nut Wrench
J-9787	Injector Tester
J-8538-10	Adapter Plate (Part of J-9787)
J-7041	Injector Comparator
J-5119	Injector Tip Concentricity Gauge

SECTION 6Y - ENGINE ELECTRICAL

Tool No.	Tool Name
BATTERY	
J-22552	Battery Tester - Charger (421 Test)
IGNITION SYSTEM	
S-9704B	Spark Plug Wrench Socket
J-6296-01	Distributor Adjusting Wrench
A.C. GENERATING SYSTEM	
J-9782-1	Test Adapter Jumper Wire
J-21600	Checking Adapter
J-9782-3	Regulator Test Adapter
J-544	Brush Spring Scale
J-8529	Thermometer
J-21260	0-50 Ohm Variable Resistor
*J-23586	Poly-V Belt Tension Gauge

SECTION 6T - AIR COMPRESSORS AND GOVERNORS

*J-23573	Belt Tension Gauge

SECTION 7D - CLUTCH CONTROLS

J-8554	Master Cylinder Cover (for connecting pressure bleeder hose)

SECTION 7E - CLUTCHES

J-5901-2	Pilot Bearing Remover
*J-2619	Slide Hammer

SECTION 8 - FUEL TANK AND LINES

J-8051	Flaring Tool Kit
J-8000	Tube Cutter

SECTION 9 - MECHANICAL STEERING

J-544-01	Spring Scale
J-2927-01	Steering Wheel Puller
J-3186	Pitman Arm Puller
J-21143	Pitman Arm Remover

SECTION 9B - POWER STEERING

J-22181	Power Steering Pressure Gauge Kit
*J-23586	Belt Tension Gauge
*J-23573	Belt Tension Gauge

SECTION 12 - CHASSIS ELECTRICAL AND INSTRUMENTS

J-6408	Headlight Aimer (Single Lights)
J-6663	Headlight Aimer (Dual Lights)

*Listed in more than one section.

PROMPT DEPENDABLE QUALITY

SUPER

CHEVROLET

SERVICE